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Dear Doctor:-

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TECHNIQUE OF OPERATIONS ON THE BONES, JOINTS, MUSCLES AND TENDONS

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TECHNIQUE OF OPERATIONS

ON THE

BONES, JOINTS, MUSCLES AND TENDONS

BY

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To

DR. E. H. BRADFORD

Professor of Orthopedic Surgery, and Dean, Harvard University Medical School

THIS VOLUME IS DEDICATED AS A TOKEN OF APPRECIATION OF HIS CLEAR-MINDED JUDGMENT, HIS HIGH SURGICAL SKILL AND PROFESSIONAL IDEALS, ALL OF WHICH HAVE BEEN A CONSTANT SOURCE OF INSPIRATION DURING THE INTIMATE ASSOCIATION OF FIFTEEN YEARS PARTNERSHIP.

PREFACE

This volume has been written at the request of many of my graduate students, including surgeons who have taken the courses at Harvard University Medical School and internes in the hospitals with which I am connected.

The work contains only carefully tried-out methods which cover operations on the bones, joints, muscles and tendons, including muscle transplantations together with all the common operations for the correction of deformities and some of the less usual ones. It is intended as a practical guide for advanced students, and for the surgeon who desires to select one of several tried-out methods for any special case.

I have endeavored to give the important details of all procedures in order to freshen the surgeon's memory before operating. The history and origin of the operations is omitted for the sake of brevity. An attempt is made to give the more useful rather than to enumerate all operations that can be done. I have not planned to compile an encyclopedia but to present a ready reference for the technique of the more practical operations on the upper and lower extremeties.

The operative procedures, useful in infantile paralysis, are dealt with at length and the tried-out methods are here recommended rather than every possible operation.

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* Soutter operation.

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TECHNIQUE OF OPERATIONS

PART I—HIP

CHAPTER I

OPERATIONS FOR CONGENITAL DISLOCATIONS AND DEFORMITIES OF THE HIP

1. Simple Manipulation for Congenital Dislocations of the Hip.—The manipulation of the hip for congenital dislocation of the hip where much force is necessary should never be done unless the patient has been walking on the leg at least three weeks. Where the manipulation is done in infants, if much force is required, it is better to wait until they can walk or creep satisfactorily. There is very much less chance of breaking the bone when it has been used in weight bearing for three weeks or more. For simple manipulation, the patient may be put lying on his face, the thigh over the side of the table. Pressure is put on the trochanter, with one hand the hip is flexed and gradually abducted with simultaneous pressure over the trochanter, pressing the head into the acetabulum.

Second method

The patient is placed on his back, assistants hold the pelvis by pressure on the anterior spines and pubic symphisis. The operator flexes the hip and abducts gently while he presses the trochanter upward, rotating the femur inward or outward as the case requires. When the head is in the acetabulum, the capsule and muscles should be stretched, forcing the head well into the socket until the femur can be brought parallel to a line passed through the anterior spines, and slightly beyond so that the knee will be above and posterior to it.

When a dislocation of the hip is present, and the hip has been out for a long time and locomotion has been possible, the hip is often very difficult to replace. At times it will be necessary to do a fasciotomy at the hip (see section 9) to relieve the hip flexion and then reduce the hip. In difficult cases the Bradford congenital hip machine (see figures 1 to 3) will make the reduction possible or more simple. Whenever the surgeon has a difficult case to reduce he should have this machine at hand. This apparatus is not effective in these cases because of traction, but in its varied methods of using leverage for reduction and after reduc-

tion to assure a complete stretching of the capsule and other contracted tissues. Difficult cases that cannot ordinarily be relieved may be reduced by this machine. Failing to reduce the hip by ordinary methods, the Bradford congenital hip machine is employed (see figures 1 to 3).

2. The use of Dr. Bradford's Congenital Hip Machine.—The patient is etherized and placed on his back on Dr. Bradford's congenital hip machine. The sacrum rests on the flat portion of the apparatus with the tuberosities of the ischii resting firmly against the uprights. The pelvis is fixed by oval metal levers pressing on the anterior superior spines and pubic bone. The screws are tightened which hold these levers in place, firmly fixing the pelvis. While the patient is being placed in position, a legging is attached around the foot and ankle (see figures ep fig. 1). The traction rod (see figures dm fig. 1), is next placed in position and extension applied (see figure 3). The hip is stretched in adduction and hyperextension and then in hyperextension and abduction. During the hyperextension and adduction, the surgeon rotates in and rotates out while the traction is in force. The joint is gently stretched and relaxed, the operator applying force in a gradually increasing manner until considerable force is used and finally relaxed entirely. In this manner a rhythmic application of force is kept up. No rough or forcible extension without a gradually increasing or gradually decreasing force should be employed. By this method a minimum amount of trauma is caused. A joint that at first will seem almost impossible to move will often give way and stretch down. Where the muscles are hard and firm it is an advantage not to overstretch as they all are useful in maintaining the hip in the acetabulum. When the lever (see figure c, fig. 1), is placed under the trochanter with the leg extended, the leg is gently abducted and the surgeon uses the lever to lift the head into place

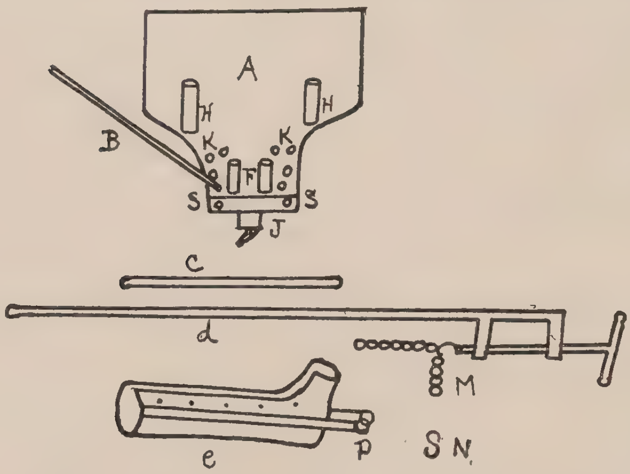

FIG. 1. Dr. Bradford's congenital hip machine. A, Plate to be thumb screwed to a table. B, Lever rod in position; used to press on the trochanter and force it upward. C, Lever rod. D, Traction rod. E, Traction legging, one for each leg. F, Perineum rods. H, rods to hold ilium. J, Screw clamp to fasten to table. K, Holes for lever rod as it is changed for different points of leverage. M, Chain to hold legging. N, S-hook to close the chain. P, Rings in legging through which chain passes. S, The holes to receive traction rods.

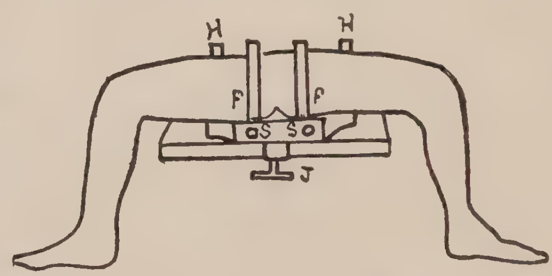

FIG. 2. Patient on Bradford Congenital Hip machine. Dr. Bradford's congenital hip machine (Front view). F. Perineum rods. H, Rods to hold ilium. S, Holes for traction rods. J, Screw clamp to fasten to table.

during the application of traction. Sometimes this is sufficient for reduction. As soon as the head is lifted over the rim of the acetabulum, the traction is removed. The operator flexes the hip in slight adduction, places the lever snugly under the trochanter, abducts and gently rotates in and out. As the head slides over the edge of the acetabulum more abduction is made, increasing the force as the operator assures himself that the head is over the rim. Stretching should be continued until the capsule has been thoroughly pulled out and the head comes forward, filling the space under the artery. When the lever is in position holding the trochanter well forward the femur should be flexed and abducted, the line of the femur forced back so that the knee will be posterior to a line drawn through the anterior spines, and abducted above it (see figure 4).

When dealing with marked anterior position of the neck it is often necessary to use the lever, not under the trochanter, but above it, pressing the head downward, traction being applied at the same time that the lever is being used.

During the application of plaster the position should be maintained by a skilled assistant in order that a dislocation at this time will be im-

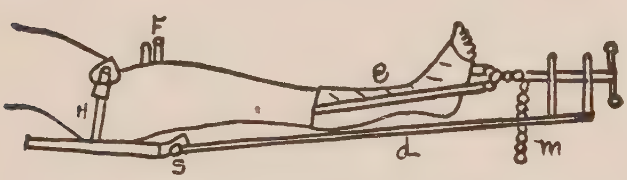

FIG. 3. Traction applied. H, Rods to hold ilium. F, Perineum rods. S, Hole for traction rod. D, Traction rod. E, Traction legging. The leg may be abducted hyperextended flexed or adducted and traction applied in the same way.

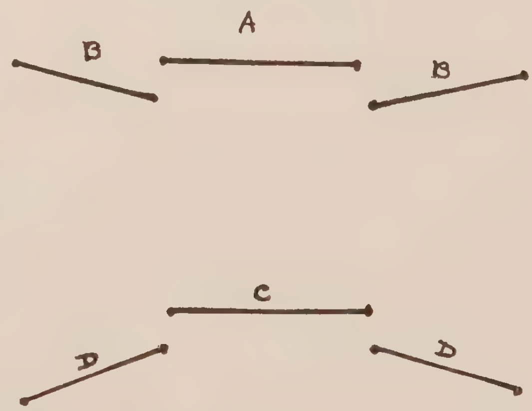

FIG. 4. A, A line connecting the anterior spines looking at the patient from above. B, The abducted position of the femur with reference to the line A. C, A line connecting the anterior spines viewed from in front of the perineum. D, The line of the femur below the horizontal when the knee is depressed.

possible. The plaster should include the pelvis, re-enforced in front and behind, holding firmly the tuberosity of the ischium and the great trochanter of the leg operated on. It should fit the thigh and leg and foot (see figures 12 to 14). The plaster is bivalved, which will allow the front to be removed easily for inspection of the leg. The patient is placed on a Bradford frame (see figures 8 to 11), which makes it easy to move and carry him. The Bradford frame is elevated from the bed if the patient is put up in the Mueller position. Whether the Lorenz or modified frog position is used or the Mueller depends on the operator who will select the more stable position for the individual case. If possible the Mueller position should be adopted. With it inward rotation of the hip as seen in figures 13, 14 is obtained at the time of the operation, while with the Lorenz position, the hip is outwardly rotated and must be inwardly rotated during the convalescence. Dr. Brad-

ford's machine for the reduction of congenital hip has made it possible to reduce so many hips which otherwise would have to remain out that it has been found necessary to develop an after treatment especially adapted to difficult cases; difficult because they could not be reduced or difficult because they would not remain reduced.

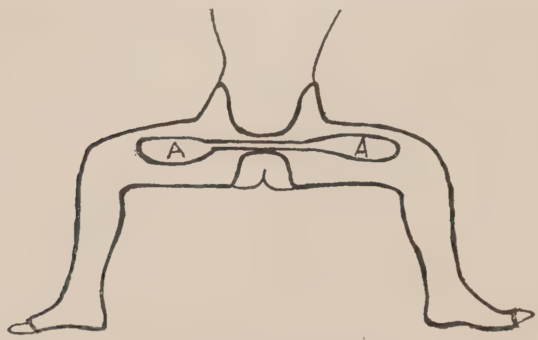

Fig. 5. Plaster of Paris bandage applied for double congenital dislocation of the hip, Lorenz position. A, Shows the plaster re-enforcement in front over the pubic bone, the re-enforcement is flattened in a plane at right angles to that at AA (see figure 6).

3. Post Operative Treatment.—The plaster is left in position for two months. At the end of one or two weeks an x-ray is taken to see the exact position of the hip. The front half of the plaster is removed for this purpose on the x-ray table. The patient remains on the Bradford frame. The front of the plaster is replaced and the patient put back to bed. After eight or ten weeks the plaster is cut away below the knee, allowing the patient to move the knee and ankle. At the end of the twelfth week, the front of the plaster is removed for a short time twice a day and the patient encouraged to kick the leg and lift the knee. The time is extended as the patient improves, until the patient is kicking the leg for about six or eight hours a day. As the muscles are seen to be strong, the patient is allowed to creep on the floor for twenty minutes twice a day with the front and back of the plaster firmly fastened. This time is gradually increased until the patient creeps six or eight hours a day. When the patient has been crawling with the plaster on for four hours a day and can do so fairly vigorously, in renewing the plaster the leg is allowed to adduct as much as it will. When the muscles are not strong any renewal of the plaster should maintain the original abducted position.

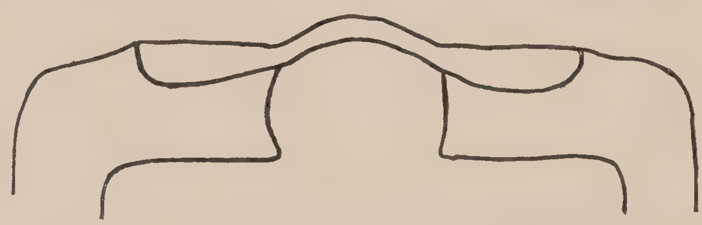

Fig. 6. Shows the bridge like appearance of the plaster re-enforcement over the pubic bone as viewed from the front.

Fig. 7. Posterior view in Mueller position. A, Plaster re-enforcement over the sacrum.

At the end of the fifth or seventh month the patient is allowed to creep without the plaster. The plaster is always re-applied at night until the patient is well. At the end of the ninth or tenth month, the

Fig. 8. Posterior view of Bradford frame showing lacing of cloth on frame and opening for use of bed pan.

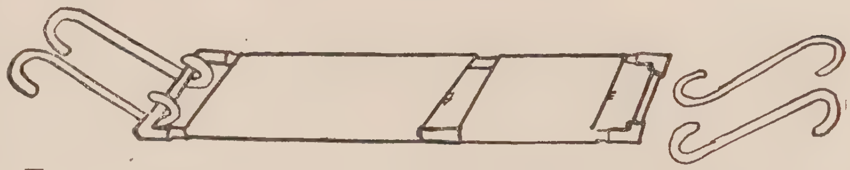

FIG. 9. Bradford frame. Showing method of elevating the frame by iron hooks to the head and foot of the bed.

patient is allowed to stand and walk for the first time. Then the hips will be found to be strong, evenly developed and resistant to dislocation by any slight falls. The patient should be seen once a month for the following six months. After that once in three or four months until locomotion is perfect.

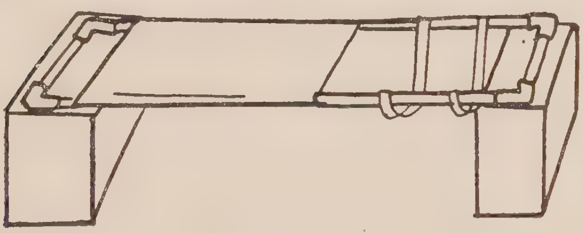

FIG. 10. Bradford frame elevated on boxes.

With this form of after treatment the hips are not likely to dislocate. The muscles are firm and strong and the patient healthy. It has been found more advantageous than that form of after treatment which allows the patient to walk and bring the legs down by successive plasters. There is no danger of stiffness for motion is started early. There is almost no danger of dislocation as the muscles are made strong from the start and they all tend to hold the head in the acetabulum.

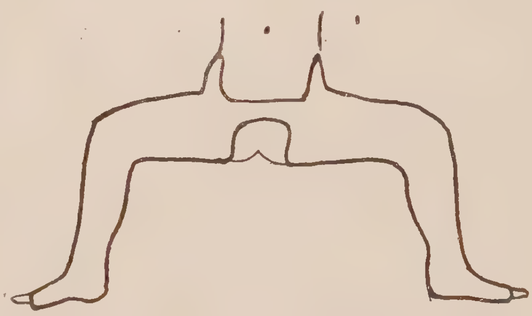

FIG. 11. Lorenz position in plaster viewed from above the bed, the feet and sacrum touch the bed.

In very strong patients, the abductors and tissues on the outer side and above the femur will resist the adduction and make walking awkward, sometimes for two or three months. Gentle stretching and massage are of advantage at this time. There is no disadvantage in this provided there is good motion at the hip. These cases are less apt to dislocate than the ones which adduct readily. The cases that adduct readily are the ones which should be watched carefully. In both types of cases the walking becomes normal gradually. There is often a roll or slight limp when the patient is tired.

FIG. 12. Lorenz position in plaster viewed from the foot of the bed. The plaster is split so that the front half may be removed and replaced.

The original position in plaster is maintained until the muscles are strong and the patient is crawling at least four hours a day with the plaster on. When the patient can crawl vigorously, in renewing the plaster the leg is allowed to adduct as much as it will and a fresh plaster is applied with the leg adducted. If the leg will adduct completely it should be put up in an abducted position of fifteen degrees. If the muscles are not strong in

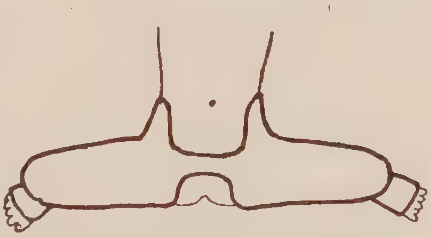

FIG. 13. Mueller position in plaster viewed from above the bed. The feet should not be abducted.

reapplying the plaster the original position of abduction to ninety degrees should be maintained. After six months, in renewing the plaster the leg may be allowed to come down straight if it will.

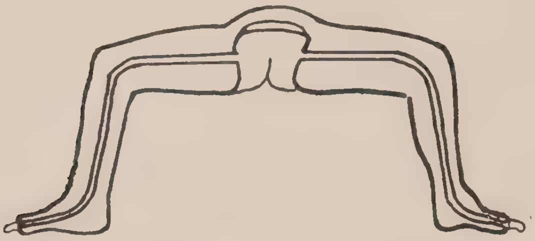

FIG. 14. Mueller position in plaster viewed from the foot of the bed. The plaster is split so that the front may be removed and replaced.

The above method of after treatment has been used about eight years. It was developed at first by the writer for those cases that it was not possible to successfully reduce without a machine for reduction, either because they redislocated and showed no permanency of result or because they were too difficult to replace by hand or by hand assisted by a traction apparatus. In many, the detail of the after treatment as described was the important factor in obtaining a permanent result. This treatment was adopted at first only for the difficult cases; now it is used by us for all cases.

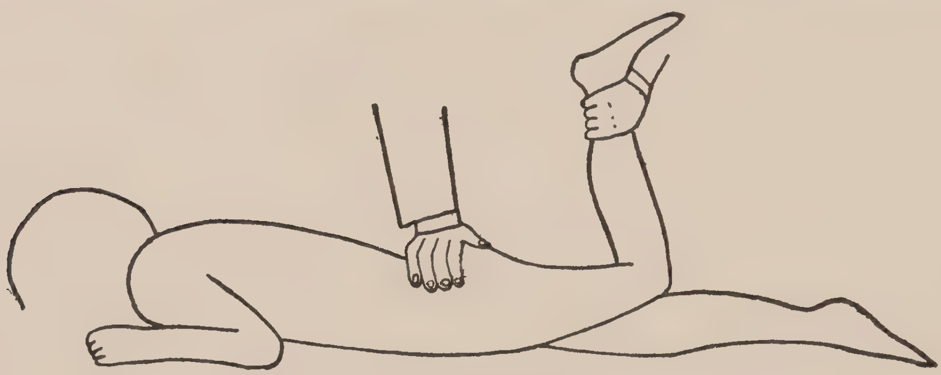

FIG. 15. Manipulation of the hip in the prone position.

Among the early cases, three were put through this method of after treatment. The course was shortened to three months. They were all running about on their legs in that time. One dislocated. Time enough had not been allowed for shortening of the capsule and growth of the bone. For this reason the time was extended to nine or ten months before allowing the patient to stand. The legs are stronger, less apt to dislocate and there is no stiffness.

FIG. 16. Manipulation of the hip. Rotation out and hyperextension.

In the poliomyelitis case or paralytic dislocation the muscles are usually weak or entirely paralyzed, making it necessary in the majority of

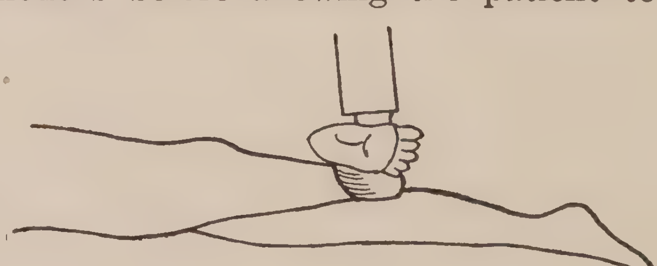

FIG. 17. Manipulation of the hip. Rotation in and hyperextension.

cases either to do an open operation and fasten the hip in the joint after reduction as above described or to do an arthrodesis at the hip in order to make it useful for weight bearing.

When there is a great deal of twist in the neck of the femur, an osteotomy of the neck or of the femur will relieve the twist. From experience it has been found that it is rarely necessary in younger cases to perform an osteotomy in thoroughly reduced heads where the after treatment is thorough. The torsion in time disappears. The twist in the neck forward will not interfere with the reduction but when it is present the surgeon should force the head well into the acetabulum and stretch the capsule completely so that it fits well around the head.

4. Open Operation for Dislocation of the Hip.—The open method for treatment of dislocation of the hip is adopted for the hip which otherwise could not be reduced or for the hip which will not remain reduced. After following the above method of treatment, when it is impossible to reduce a dislocation of the hip or when it will not remain in the socket after careful reduction and after treatment, an operation by incision becomes indicated.

OPERATION

Before preparing the skin for operation, the Bradford congenital hip machine is used and the hip reduced as described above.

After cleansing and sterilizing the skin, sterile sheets should be placed around the leg in such a way that it may be manipulated in any position by an assistant.

The operator stands outside of the leg to be operated on. An incision is made from the anterior superior spine to the upper edge of the great trochanter and then down along its anterior border. Other incisions may be preferred (see Arthrotomy at the Hip). The fascia lata and tensor fasciae femoris is retracted and the gluteus minimus removed from its insertion on the great trochanter and retracted upward and backward. The leg is forcibly abducted and outwardly rotated. The capsule is incised from above downward and from within outward, parallel to its fibers. The incision is carried down from the anterior inferior spine to the intra trochanteric line. The hip is reduced by flexing in adduction, then outward rotation or inward rotation in abduction. A sterilized lever is placed under the trochanter and all resisting tissues are separated while the head is forced into place. If necessary the head is brought out into the wound and the acetabulum and head inspected. Any constrictions of the capsule are cut, dividing them in a line with their fibers.

After placing the head in the acetabulum, the capsule is shortened by mattress sutures made with heavy silk number fourteen or number sixteen or eighteen. The deep tissues are brought together with interrupted chromic catgut sutures number 00, the superficial tissues with interrupted chromic catgut sutures number 00, the skin with continuous

chromic catgut sutures number 00. The hip is held in position by means of a plaster of Paris bandage in either a Mueller or Lorenz position (see figures 11 to 14), as described above. The after treatment varies in no way from that for congenital hip dislocation as described above.

5. Plaster of Paris for Congenital Dislocation of the Hip.—Following the operation for congenital dislocation of the hip a plaster of Paris bandage is applied as follows: stockinet or other suitable covering is applied to the pelvis and legs. Felt pads are applied over the anterior spines, over the top of the trochanter, under the sacrum and over the internal condyles of the femur. A well fitting plaster is then applied over the thighs and pelvis for a double case; or in a simple case over one thigh, with a few turns over the other, to prevent the pelvic portion from slipping up. Heavy plaster re-enforcement or plaster ropes are placed in front over the pelvic bone (see figures 5, 6, 7), along each thigh in front to prevent the breaking near the anterior spine. A similar re-enforcement is placed behind it on the sacrum and down the back of the thigh (see figures 6, 7). More plaster bandages are used to bind this re-enforcement to the rest of the plaster. The thigh of the dislocated hip or hips should be parallel to a line connecting the anterior superior spines and if possible the knees should be above this line and posterior to it. This will show good over-correction.

The plaster should pull the trochanter down and hold it firmly. The tuberosity of the ischium should be held firmly and be well padded when the part of the plaster, including the pelvis and thigh and knee is hardening. Padding is applied to the lower leg and foot and the plaster continued downward, the foot is held at right angles.

It is important to maintain the desired position of the thigh and have the plaster harden immediately maintaining the Mueller or Lorenz position while completing the plaster down to the foot. The plaster should be split into an anterior and posterior half as shown in figures 12, 14, and laced as shown in figures 460 to 464.

overlapping fracture of long standing, it is sometimes necessary in addition to having a traction machine and in addition to the operation on the joint or the fracture, to gain length in the adductor magnus by a tenotomy of the tendon just above the internal condyle.

The tendon may be felt here. An incision is made three-fourths of an inch long, the finger readily recognizes it, a director hooks it up and its fibers tenotomized directly across or by an oblique or zig-zag tenotomy. One suture will close the incision. It is sometimes surprising the relief of tension obtained by this procedure (see figure 47).

32. Operation for Gluteal Bursitis (see figure 48).—An incision is made three inches long over the great trochanter through the skin and

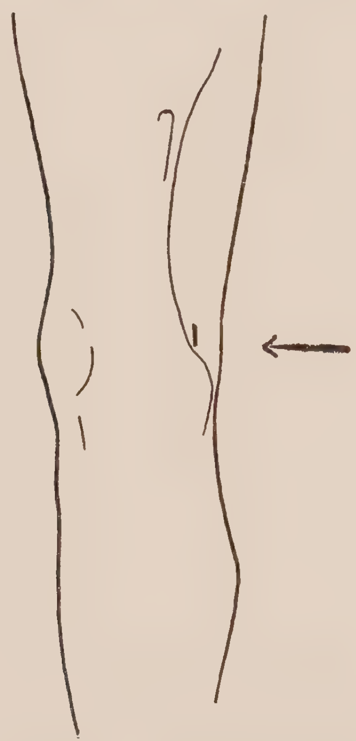

Fig. 47.—Adductor magnus incision. Incision three-fourths of an inch long. Here the tendon can be hooked up and tenotomized.

Fig. 48.—Incision for reaching the gluteal bursa.

fat parallel to the femur. This is the most convenient incision for gluteal bursitis. The fascial portion of the gluteus maximus is raised and the bursa will be found under it. The bursa may be dissected out or incised and drained.

33. Tapping the Hip Joint.—The most scrupulous aseptic precautions are necessary both as to the preparation, and the protection, of the field of the operation.

The trocar may be thrust just above the great trochanter from the side of the patient directly inward or the joint may be reached from the front external to the sartorius at the same level (see figures 49, 50). When the head or neck is reached the sharp point of the trocar may be withdrawn and the dull end used as a probe to locate the exact point

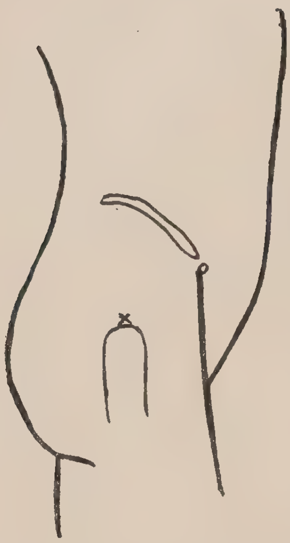

Fig. 49.—Tapping the hip from the side.

before using the trocar point again. The neck is reached easily and then the head, further inward. The trocar point is then inserted and the joint tapped.

When there is much effusion it is not difficult to reach the joint. The skin is drawn to the side so that the hole in the skin and muscle will be out of line when the needle is removed. If fluid is to be withdrawn, and other solutions are to replace it, the amounts should be carefully measured. Two good graduated metal syringes are very useful. All of their parts should be tested beforehand. The trocar is made to enter the joint and then is connected with the syringe. As little air as possible should enter the joint. The trocar should be of large diameter as the fluid may be thick or flaky. When the patient is not anæsthetized for the operation it is often well to have a short flexible tube connect the trocar with the syringe. This should be fastened at both sides by silk ties so that it will not leak easily when pressure or suction is used. If the joint is to be washed out a definite amount of fluid is injected and the return measured in a sterilized measuring glass.

Dr. Murphy uses a formalin glycerine solution as follows:—

Liquor formaldehyde, 2% in glycerine, about ten drops of the formaldehyde to each ounce of glycerine. This acts very well in infectious synovitis. But it should not be used in arthritis deformans nor in old chronic arthritis. The tapping may be done with ethyl chlorid or novocaine adreneline solution, 1%. The solution should be prepared twenty-four hours before it is used (Murphy).

Fig. 50.—Tapping the hip, just outside the sartorius at a point one-half way between the top of the trochanter and the artery, at Pouparts ligament.

CHAPTER V

OPERATIVE TREATMENT IN CASES OF HIP-JOINT ANKYLOSIS

34. Principle of Arthroplasty for Ankylosis of the Hip.—Ankylosis may be bony, cartilaginous or fibrous, it may be periarticular, ligamentous and capsular, or extra articular, that is, skin scars, tendons, fascia, nerves and arteries.

The form of ankylosis that exists will determine the treatment. A partial ankylosis at certain points had better not be treated by an arthroplasty.

Age must be considered, also the general condition of the patient. When the ankylosis is bony, cartilaginous or fibrous, arthroplasty is indicated. When the condition is periarticular or extra articular, it may be treated by capsulotomy, tendon elongation, excision of exostoses, etc.

Dr. Murphy lays stress on the following points: The principles of asepsis to the finest detail are absolutely essential. One not familiar with the best surgical technique should avoid arthroplastic operations. The exposure of the joint must be generous and careful. The excision of the ankylosis must be complete. The contracted capsular ligaments and soft parts must be freed and if necessary lengthened. The normal contour of the joint should be restored as near as possible. The operator should obtain a hyper-mobilization of the joint. The joint should be re-shaped to give stability. The inter-position of material to prevent reunion of the bone is necessary. The principle is to separate the bones and to interpose between them material to prevent ankylosis. The best material for this purpose is the human pedicle, composed of fat, muscle, fascia, or a combination of these.

When this is not possible, a transplantation is made of fat and fascia from the trochanter bursa region or from the fascia lata.

Material such as ivory, celluloid, silver are *not* good. Materials that will not absorb or that absorb too slowly are not desirable.

During the operation the soft parts should be freely liberated. Attach the interposing flap to one bone only and cover it completely. Early motion, that is, at the end of five to seven days is necessary with or without gas or gas oxygen.

Dr. Murphy records failures in arthroplasty as due to first, insufficient and defective exsection of the capsule and ligaments, second, insufficient interposition of fat and fascia between the separated bony surfaces, third, infection, fourth, the sensitiveness to pain on motion after operation.

Cases of primary tuberculosis and cases of recent infection that have

subsided are not suitable cases for arthroplasty. In operating, in addition to the usual protection of the field of operation, after the skin and fat have been incised, towels should be clamped to the edges of the skin.

35. Technique of Arthroplasty at the Hip.—Dr. Murphy recommends a U-shaped incision for Arthroplasty at the hip the sides of which are about five inches long and three inches apart. He starts one and one-half inches above the trochanter and one inch behind. The incision extends two inches below the top of the trochanter. The trochanter should be in the centre of the U. This will give a piece of fascia lata four inches wide and five inches long for use as a flap. The anterior portion of the U starts one inch below and one inch anterior to the trochanter and extends up five inches in a straight line to the anterior superior spine of the ilium. The skin and fat and fascia are retracted upward, exposing the trochanter, the top of which is removed with its muscles attached, the operator being careful not to weaken the attachment of the neck in removing the top of the trochanter. A large heavy needle threaded with silk is passed behind the top of the trochanter; to the silk is attached a chain saw. This is used to remove the top of the trochanter, the obturator and pyriformis muscles are detached and retracted. The capsule is separated subperiosteally from the neck of the femur, a number of silk sutures with long ends are placed in the capsule so that it may be easily recognized later on. The long ends are attached to clamps which help to hold the capsule retracted. The capsule should remain attached to the acetabulum. A curved chisel is used to separate the head from the acetabulum following the normal outlines of the joint, and extending inward one inch between the bones all around.

Dr. Murphy's globular drill and cup-shaped endmill will smooth out the cavity and make a round shaped head of the femur. The flap of fascia and fat taken from under the skin are now placed inward and sutured to the remnant of the capsular ligament or may be covered over the whole head and neck of the femur. After replacing the head in the acetabulum, the capsule is sutured, the trochanter is replaced, the separated obturator and pyriformis muscles are reattached. An eight or six pennyweight nail is used to hold the trochanter in place. The muscles are brought together with interrupted chronic catgut sutures number 00, the fat with interrupted chromic catgut sutures number 00, the skin with continuous chromic catgut sutures number 00. Buck's extension apparatus is applied with twenty pounds' weight holding the leg in an abducted position. The patient is kept in bed for seven to ten days with this apparatus. After this, passive motion in flexion is introduced depending on the amount of pain or motion. The passive motion is used daily. Lateral motions are begun later on. A removable splint or plaster is applied for three or four weeks and removed when a fair degree of motion is possible without pain or great discomfort. The patient is then allowed to get up with crutches and swing the leg.

cision is carried down through the skin and fat, exposing to the muscle layer.

For simple drainage the muscle fibers of the gluteus maximus may be separated and some of the fibers cut. Or, the aponeurosis of the gluteus maximus is separated from the great trochanter, also some of the fibers of the gluteus minimus, and the muscles are retracted, exposing the capsule of the joint. This is separated parallel to its fibers.

FIG. 44.—Anterior U-incision, from below the anterior superior spine downward just outside the artery, then outward and upward along the trochanter. Brackett.

22. U-Shaped Incision used by Dr. Murphy for Arthroplasty.—Dr. Murphy recommends a U-shaped incision for Arthroplasty at the hip, the sides of which are about five inches long and three inches apart. He starts above the trochanter and one inch behind. His incision extends two inches below the top of the trochanter. The trochanter should be in the centre of the U. This will give a piece of fascia lata four inches wide and five inches long to use as a flap. The anterior portion of the U starts two inches below and one inch anterior to the trochanter and extends up five inches in a straight line to the anterior superior spine of the ilium. The skin and fat and fascia are retracted upward, exposing the trochanter, the top of which is removed with its muscles attached, the operator being careful not to weaken the attachment of the neck in removing the top of the trochanter.

FIG. 45.—Side view of U-shaped incision. (See figure 44.)

23. Anterior U-Incision (see figures 44, 45).—Dr. Brackett recommends the use of a U-shaped incision; the inner incision extends downward from just below the anterior superior spine five inches, keeping just external to the artery, then three to four inches across the leg and five inches upward anterior to the trochanter. The sartorius is recognized and retracted inward, with the rectus, the tensor fascia femoris outward.

24. Internal Lateral Incision. Adductor Incision for Exposure of the Hip.—The hip is flexed ninety degrees, abducted ninety degrees and outwardly rotated ninety degrees. An incision five inches long is then made along the border of the adductor longus. The adductor longus is retracted inward and the pectineus outward. This incision is sometimes recommended in dislocations as it is the most direct route to the ilio femoral

ligament which is often the obstacle preventing a successful reduction of the dislocation.

25. Arthrotomy for Fractures About the Hip.—The necessity of immediate operation in fracture about the joints depends, as in other fractures, on the acuteness of the local and general reaction. When these do not contra indicate immediate operation, certain fractures about the joint may require treatment by the open method. Among these are fractures of the patella, fracture of the olecranon, certain fractures of the surgical neck of the humerus, and certain fractures of the neck of the femur, all compound fractures, even when the protrusion of the bone has been extremely slight, all fractures that cannot be maintained, or where apposition is impossible, many fractures combined with dislocation, articular fractures with pieces locking or limiting the joint action. See figures 67 to 70.

Where there is a great deal of trauma and in multiple fractures and in cases where there is a great deal of shock all that can be done is to immobilize the parts until a favorable time for operation. In selecting a suitable time for operation the surgeon must remember that when it is found necessary to operate on a fracture if there is no immediate contra indication, the sooner it is done the better. Where there is tremendous swelling the surgeon should always wait. All cases should be operated on that show no union after three months of good treatment.

Methods of treating the individual fracture cannot be considered in a limited space like this. The writer has described the routes of approach to the different joints and the technique of these. This will enable the surgeon from his knowledge of fractures to select the route best adapted for the individual treatment required and when necessary two or more incisions may be used. A knowledge of the technique will enable the surgeon to work rapidly in reaching the fracture on which he expects to spend time.

26. A Method of Treating Overlapping Fractures.—Where the bones overlap, an excellent method of treatment is one suggested to the writer many years ago by Dr. Edward Martin of Philadelphia. In the operation when the surgeon has reached the fracture the ends are freed. A tough tape or webbing is used ten or twelve feet long and is sterilized. The two ends of the tape are tied together, a loop of the tape is placed over the distal end of the bone. The other end of the tape is thrown over the foot of the operating table, a thirty-five pound weight is attached to this by an assistant. In about five minutes the bones will be found to be separated at least one inch. The weight is then held up by a non-sterile assistant, the tape taken off of the end of the bone and clamped to the sheet on the operating table, so that it will not slip away while the surgeon works on the fracture. When the muscles are in fairly good tone or the overlapping of bone has been great, it will be found that the bones will overlap again in four or five minutes. A reapplication of the tape will separate the bones again for the same

length of time. The end of the lower bone should not be cut or freshened until all other procedures are done which require separation of the bone. When these have all been done the end of the bone over which the tape has been placed is freshened. After this the tape should not be placed on the end of the bone, but the two ends allowed to come together and held by a clamp until the operation is complete.

Very bad overlapping fractures have been treated in this way in fresh cases without the necessity of shortening the bone. In old fractures no more bone need be removed than is required by the conical condition of the ends of the bone.

27. Fractures of Long Standing Still Ununited or United with Deformity, Preventing Function.—In fractures of long standing where there is a mild infection, conservative treatment should be tried first. When this has been tried free drainage should be established and at the same time the ends of the bone freshened up slightly. Unless the infection is marked, in many of these cases when the suppuration disappears, union has also taken place. In any case where there has been infection, no plastic operation should be performed until infection has been entirely absent for at least nine months; a year is safer. Where the infection is very mild and of long standing, during the process of treatment the patient may be allowed to walk on the other leg if the local reaction is not too great. Sometimes he may walk a little on the affected leg. It is of advantage in certain cases to use a Thomas knee splint to take some of the weight off of the affected leg, the patient being allowed to bear weight on the ball of the foot, the splint taking all the weight off of the heel. Where the x-ray shows conical ends of the bone it is practically useless to expect union without surgical interference. The Carrell-Dakin technique is advisable in infected cases. See section 323.

28. Fractures of the Neck of the Femur in the Young or Middle Aged.—In recent fractures of the neck of the femur, Dr. Whitman's technique is most satisfactory. Under anæsthesia, manual or mechanical traction is applied to both legs. The good leg is abducted to determine the amount of abduction possible. The fractured leg is pulled on and abducted while the surgeon presses on the trochanter, reducing the deformity and guiding the leg into extreme abduction and hyperextension, and outward rotation is also corrected. A plaster of paris bandage is applied to the thorax, pelvis, thigh, leg and foot holding the hip in extreme hyperextension and extreme abduction; it should fit well. (See application of plaster for the hip and thorax.) A Bradford frame is used under the plaster. A well fitting plaster enables the patient to be moved after the first five days without disturbing the fracture. The bed may be lifted at the head to relieve any tendency to hypostatic congestion. The leg of the plaster rests off of the bed as described for plaster following osteotomy at the hip. The patient may be put on a bed rest at the end of two weeks, if necessary, the well leg remains on the bed; the leg in plaster is off of the side of the bed. The after treat-

ment is otherwise the same as for osteotomy at the hip. The age of the patient must be considered. The results are very excellent. However, in the very feeble it may take one year before the patient is able to walk well, but then it is due to feebleness rather than lack of function. The hyperextension of the hip, the reduction of the deformity, the extreme abduction and correction of the outward rotation will favor good function. In cases with osteoarthritis there is some danger of stiffness with any fracture. Fractures of the neck may be adjusted and nailed or bone pegged. In the old, the fracture is often impacted and should be disturbed as little as possible. The danger from pneumonia or hypostatic congestion is worse than the fracture. In younger subjects, an incision is made and the fracture adjusted. See figures 59 to 62. Traction on the trochanter is made as described for overlapping fractures and the head and neck pegged, nailed, wired or grafted. The trochanter and neck are drilled and a tight prepared bone or other peg driven into the hole made by a drill the size of the peg and if possible tapered so that it may be driven tight.* The patient is put up in a long plaster spica from the nipple line to the toe and immobilized in bed for four to five weeks, and then gotten up with crutches and the spica cut off below the knee. Old fractures of the neck with an excursion of the trochanter may be adjusted by pulling down the leg as far as possible, then cutting the trochanter to fit the head or the denuded acetabulum. This gives a firm hip sometimes with forty to eighty degrees of motion, sometimes very little motion. Walking is, however, much improved and later the other leg may be shortened if the difference is great (see paragraph 42). It should be remembered as pointed out by Whitman that full abduction and hyperextension is the best position for a recent fracture of the neck.

Fig. 46.—Incision for reaching the sciatic nerve.

29. Coxa Vara. Operation.—In operations for Coxa Vara, an anterior or antero-lateral incision may be used unless a trochanteric operation is decided upon. This latter operation is the most satisfactory (see Subtrochanteric Osteotomy).

30. Incision for Exposure of the Sciatic Nerve.—An incision in the median line is made three inches long on the posterior aspect of the thigh beginning at the fold of the buttock dividing the lower fiber of the gluteus maximus and separating the tissues below this muscle by blunt dissection. The sciatic nerve can be felt with the finger. A full view of the nerve is obtained when the muscles are separated (figure 46).

31. Incision of the Adductor Magnus Tendon in Hip Operations.—In manipulating a dislocated hip or a shortened leg due to

* As described by Hawley.

The reader is referred to other pages for the detail in applying a plaster of Paris after hip operations (see section 10). A good traction machine and a well applied plaster are essential for the best results after osteotomies whenever extreme deformity at the hip exists.

38. Operation for Coxa Vara with Ankylosis.—A subtrochanteric osteotomy as described above is the simplest and an effective way of correcting coxa vara. The removal of a wedge of bone from the trochanter is more complicated and rarely necessary.

The after treatment is the same as in osteotomy at the trochanter.

39. Osteotomy at the Neck of the Femur.—Osteotomy at the neck of the femur to correct deformity here or for coxa vara is sometimes indicated. The neck is reached through an antero-lateral incision from the anterior spine to the top of the trochanter and then extending downward two or three inches along the front of the trochanter. The gluteus medius and tensor fascia femoris are separated and the neck is easily reached. A drill may be passed through the head of the femur and another through the trochanter. These are placed firmly in the bone and should be placed parallel to each other. The neck is cut with an osteotome and the leg put in the desired position. This operation should be done with the patient on a traction machine so that there will not be any over riding of the fragments. If necessary a bone peg is passed through the trochanter neck and head of the bone after correcting the deformity, the drill ends are now used to guide the position of the head and hold it into place while applying the bone graft or wire nail. The drill should be a little smaller than the nail or graft or a tapered bone peg may be used as suggested by Dr. Hawley.

In most cases of deformity of the neck, an osteotomy through the trochanter will give the same result as to correction and will have the advantage of simplicity, also the bone is thick and heavy here, making good repair an assured factor. The operation is some distance from the joint so that it will be injured as little as possible.

This operation should be done with a traction apparatus as described in these cases.

The after treatment for osteotomy through the neck is the same as for osteotomy through the trochanter.

40. Albee Hip Operation in Osteo-arthritis for the Relief of Pain. Arthrodesis.—In osteo-arthritis at the hip, Dr. Albee has suggested a method of obtaining ankylosis by a partial excision in situ. This operation is especially adapted to the adult arthritic case with severe pain and in no instance should it be used where there is active disease or when there has been tuberculosis or suppurative joint disease.

An antero-lateral incision is made, the head exposed, but not dislocated, its upper and inner surface chiselled away (see figures 39 to 44) in situ, also the upper surface of the acetabulum removing a quadrilateral piece of bone partly from the head and partly from the upper acetabulum. When this space closes the bone should be

CHAPTER VI

OPERATIONS IN SUPPURATIVE CONDITIONS ABOUT THE HIP

43. Suppurative Conditions at the Hip Joint.—In suppurative conditions at the hip joint an anterior incision may be used. If the disease is extensive or very acute this should be combined with an anterior lateral incision and a posterior. A single incision is rarely enough.

Tubes are placed to the joint from each incision; gauze is used to gap the corners and make them round.

When the acetabulum is extensively diseased and the condition is progressively growing worse, the head should be dislocated and the acetabulum drained and a large opening made through it. The bone anterior to the acetabulum below the anterior spine may be chiselled away with the softened diseased parts of the acetabulum. While this may be indicated in adults, in children the worse cases of bone disease will often recover in time, following good drainage and without radical measures applied to the bone. In all cases good drainage should be established first and any radical measures applied to the bone should be reserved for those cases where good drainage is not sufficient. See section 323, Carrell-Dakin technique.

44. Excision of the Hip in Suppurative Conditions.—The hip is approached as described for arthrodesis (see section 12). The amount of bone to be removed will depend on the amount of disease present.

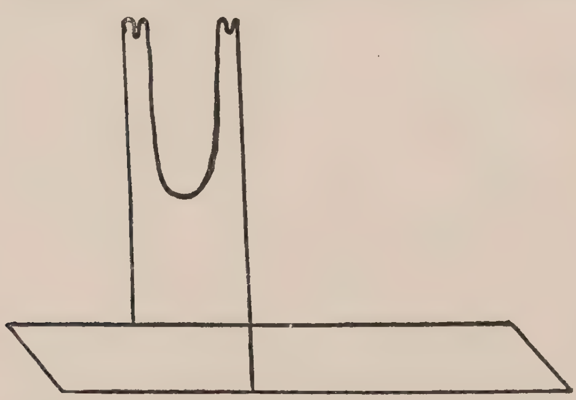

Fig. 67.—Heavy bent wire frame. Wire splint for fracture of the femur in infants. The frame is covered with canvas as described for the Bradford frame. The head and body rest on this. Diapers are placed under the hips. Traction is applied to the legs lifting the hips very slightly off of the frame as shown in figure 68.

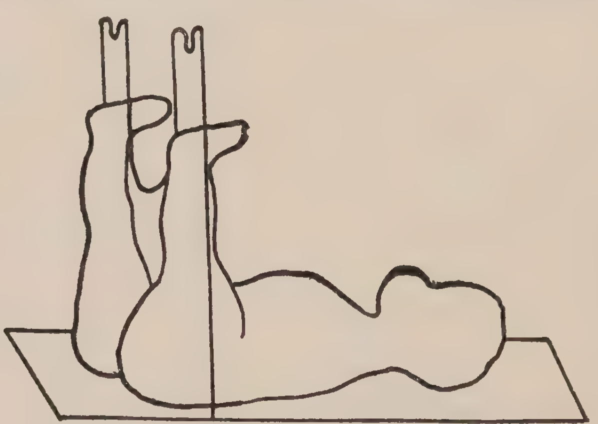

Fig. 68.—Showing patient in position.

45. Methods and Principles of Drainage in Acute Non-tubercular Suppurative Joint Disease. Hip.—A small suppurative focus without virulence or active constitutional disturbance should be drained by a suitable incision, wiped out with gauze, a tube placed to its deepest part and the soft tissues gaped with gauze.

36. Operation for Deformity at the Hip with Joint Ankylosis. Hip Flexion and Adduction with or without Dislocation of the Hip. Operation for Coxa Vara.—Where the tissues have been contracted about the hip over a long period of time and the hip not dislocated, there is sometimes a fibrous ankylosis at the hip which maintains the position of deformity even after an operation is done to relieve the contracture of the soft tissues. Often after dislocation a practical ankylosis exists. Where this ankylosis is very slight and not due to previous tuberculosis it is advisable to limber up the hip joint by manipulation as described in these pages elsewhere. When the ankylosis amounts practically to an arthrodesis or when an arthrodesis has been done and deformity of flexion and adduction have developed, it is often advisable to do a Gaunt or subtrochanteric osteotomy and correct the deformity. Even when walking is possible with a flexed and adducted hip, there is a tremendous expenditure of energy due to the awkward and back straining position; with this position there is often pain in the hip and back which eventually makes locomotion impossible. These conditions are relieved by straightening the leg and should not be left till the patient is disabled. When deformity and ankylosis exists the operation of choice is an osteotomy. See figures 494 to 496.

FIG. 51.—Diagrammatic cross section of bone. Shows inclination of the osteotome when cutting the anterior bone surface and method of holding it inclined anteriorly.

FIG. 52.—Shows the method of cutting the bone in sections on the anterior surface.

37. Subtrochanteric Osteotomy, "Gant."—When under anæsthesia (for operation on the right hip) the patient is placed on the left side, the left hip and knee being flexed to add stability to the position. Sand bags and pillows are arranged about the chest to prevent the patient from rolling. The operator stands behind the patient, the skin being prepared and the operative field protected. The osteotome is introduced over the outer side of the trochanter subcutaneously with the blade parallel to the line of the femur about one or one and one-half inches below the top of the trochanter. When the periosteum is felt with the cutting edge of the osteotome, the blade is turned so that it lies across the bone. The bone is cut across slightly obliquely from without inward and downward, the operator cutting and then feeling, using the osteotome as a probe, then cutting what he feels with the osteotome. An open incision is of no advantage. The

FIG. 53.—Shows further cutting of the bone surface (sections three, four and five will be cut in succession).

bone is cut through on its anterior surface inward, then another portion is cut posterior to this, working from without inward, and so on backward until the bone is entirely cut (figures 57, 59). When the bone is cut through this can be determined by feeling with the osteotome, an assistant lifting the leg and gently abducting or rotating the femur. Crepitus is felt when the bone is completely cut through. If a very little remains to be cut it will break readily as the femur is abducted and rotated. When the osteotome is withdrawn, no sutures are necessary. A sterile sheet wadding pad is placed over the small wound. The patient is placed on a traction machine after cutting the bone but preferably for the whole operation (see figures 54 to 59), and both legs pulled evenly so that the perineum rests firmly against the perineal rods. The left leg is tightened and then the right, the muscles being stretched down until good length is maintained in the short leg and about forty degrees of abduction with twenty-five degrees of hyperextension at the hip. This position is regulated and held by the traction apparatus during the application of the plaster, which should reach from the axilla to the tip of the toe of the affected leg. For 12 years the writer has used the apparatus illustrated here. Where a Hawley Table is available this should be used. The plaster extends a short distance down the opposite leg, and should maintain the hip operated on in an abducted position of forty-five degrees and hyperextended twenty-five degrees. When the plaster is completed a

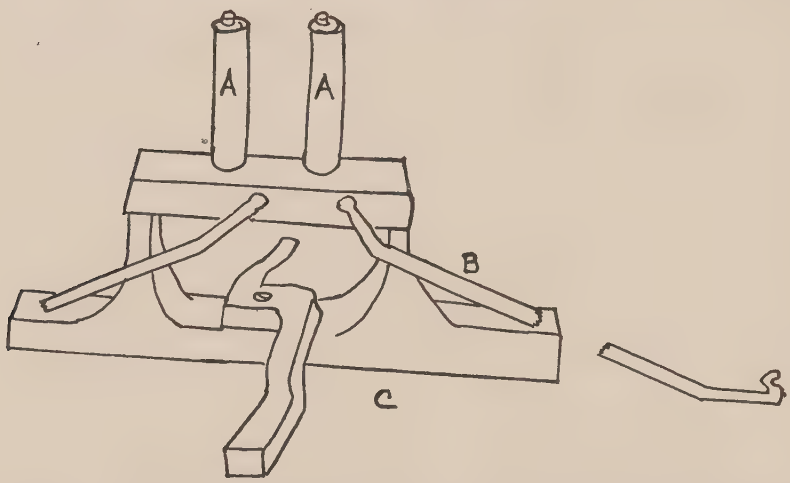

FIG. 54.—Traction machine for operation on the hip or femur holding the patient ready for plaster without change of position. Traction rods in place. A, Rollers against tuberosity of the ischium. B, Traction rod. Two like this. C, Stand to hold pelvis off of the table.

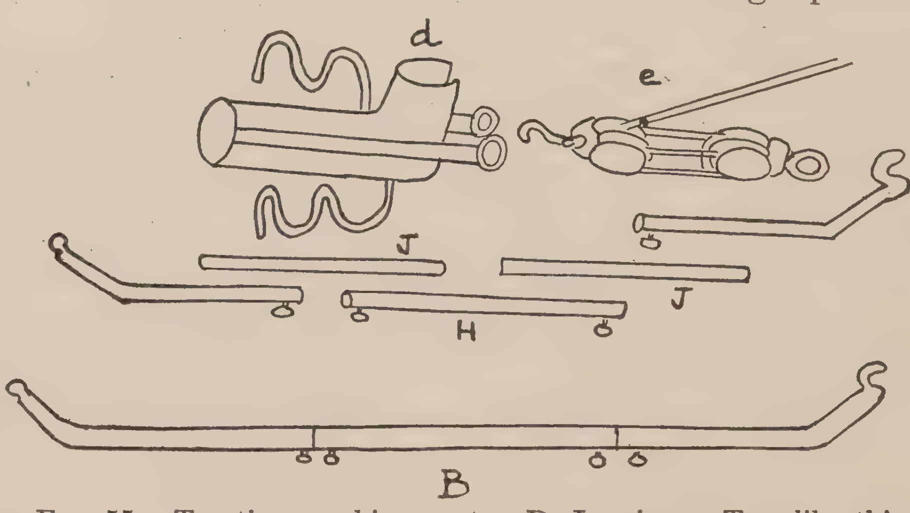

FIG. 55.—Traction machine parts. D, Leggings. Two like this. E, Pulleys. Two sets of double block pulleys. H, Disjointed traction rods. B, with thumb screws to hold inside rods. J, Rods that fit inside the traction rods. The stand for the thorax is similar to (C) only broader.

window is cut over the abdomen and the plaster is removed from the back of the thorax down to the lumbar region and from the side

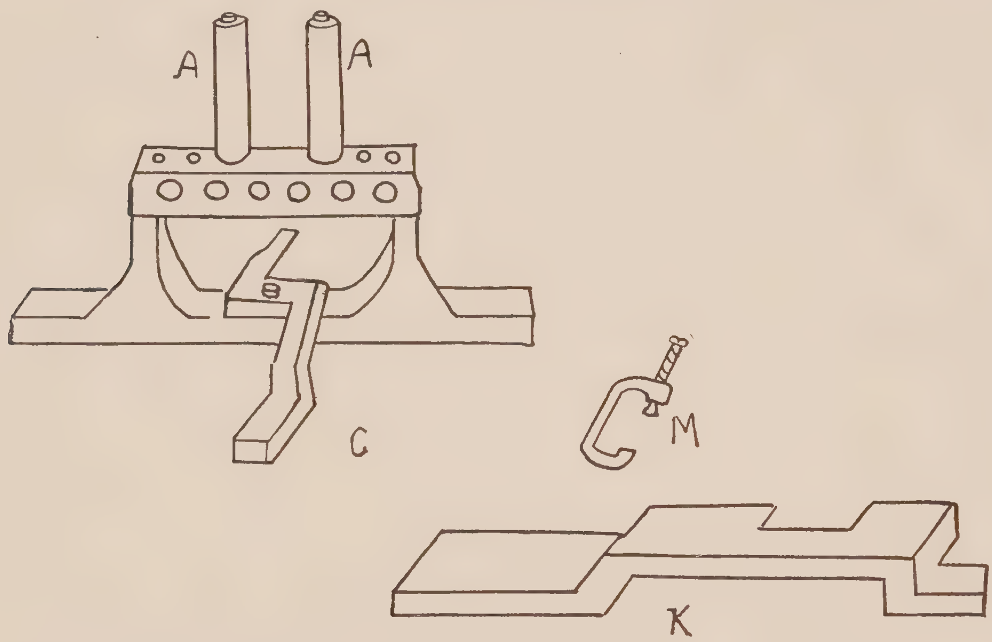

FIG. 56.—Traction machine for operation on the hip holding the patient ready for plaster without change of position. A, Rollers against tuberosity of the ischium. C, Stand to hold the pelvis off of the table. K, Extension used to clamp thorax and to clamp pelvic stand to table. There are four extension clamps like (K).

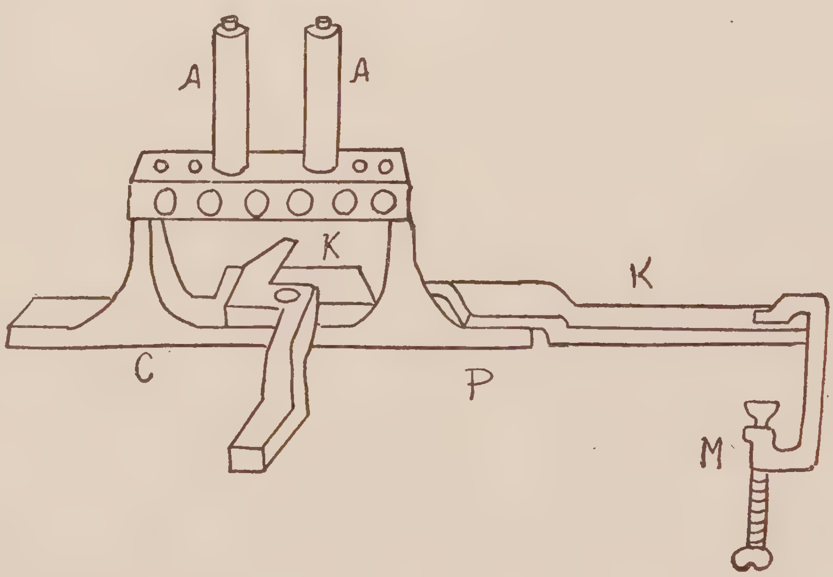

FIG. 57.—Traction machine for operations on the hip holding the patient ready for plaster without change of position, clamps holding it firmly to the table. A, Rollers against tuberosity of the ischium. C, Stand to hold pelvis off of the table. K, Extension used to clamp thorax stand and to clamp pelvic stand to table. M, Clamp. There are four like this. P, Shows extension clamping pelvic piece to table.

operated on as far as the crest of the ilium (see figures 25 to 29). This allows abduction and hyperextension but not the reverse. The surgeon can assure himself of the abducted position by feeling the anterior spines when the plaster is still soft, and as soon as the plaster is cut out he may put his hand through the window in the abdominal portion of the plaster and ascertain the position of the anterior superior spines in order to be certain that the abducted position has been maintained. The patient and plaster are placed on a Bradford frame and handled and moved on the frame. The patient is kept on his back for six weeks, after that he sits up in the

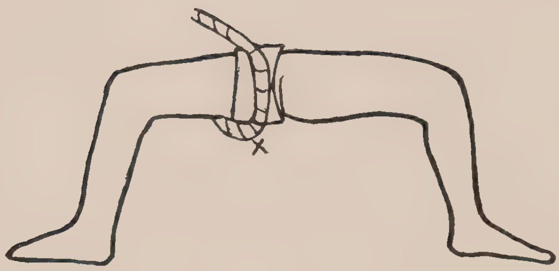

FIG. 58.—To prevent slipping of the plaster. Method of applying plaster to tuberosity of the ischium by a plaster rope (X) over felt padding, using traction machine (see figure 57).

plaster, on the edge of the bed, keeping the good leg in the bed, bending the good hip. In four days more he is allowed to stand on the good leg and encouraged to walk as soon as his strength allows. When he is able to keep his equilibrium for fifteen minutes a lighter plaster is applied holding the pelvis and the leg above the knee. Walking is encouraged on the operated leg in the seventh week. A leather spica should be used for about a year to prevent adduction.

CURVED OSTEOTOMY AT THE BASE OF THE TROCHANTER

Dr. Brackett's Modification

Instead of doing an oblique osteotomy, Dr. Hoffa and Dr. Brackett make an open incision anteriorly cutting the bone in a curve from within outward and slide the bone in this curve into an abducted position.

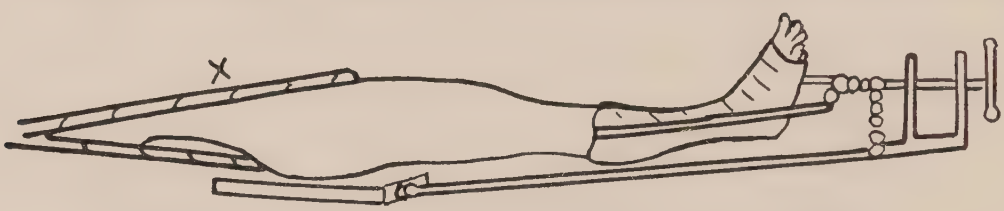

FIG. 59.—Shows rope (X) pulled towards patient's shoulder.

Removal of a Wedge of Bone

If the operator prefers he may remove a wedge of bone from the femur, close the gap and cause abduction and hyperextension. The bone may be sutured or wired or an inlay bone graft used after osteotomy. In the majority of cases a simple osteotomy is as good as any of the elaborate methods. In any event the result will depend on gaining and maintaining the position by an adequate well fitting plaster of Paris bandage.

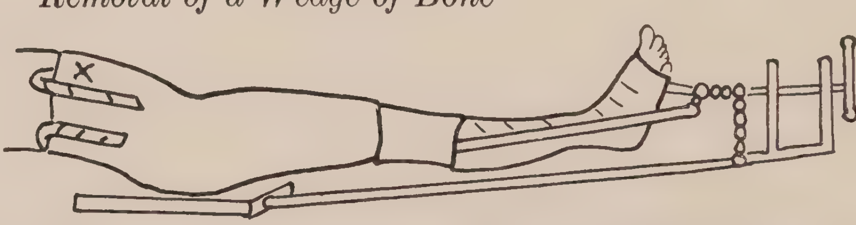

FIG. 60.—Shows the plaster applied over rope (X) and the ends turned down holding the pressure on the tuberosity of the ischium.

FIG. 61.—Represents the next stage with the plaster rope (X) buried in the plaster.

cision is carried down through the skin and fat, exposing to the muscle layer.

For simple drainage the muscle fibers of the gluteus maximus may be separated and some of the fibers cut. Or, the aponeurosis of the gluteus maximus is separated from the great trochanter, also some of the fibers of the gluteus minimus, and the muscles are retracted, exposing the capsule of the joint. This is separated parallel to its fibers.

22. U-Shaped Incision used by Dr. Murphy for Arthroplasty.—Dr. Murphy recommends a U-shaped incision for Arthroplasty at the hip, the sides of which are about five inches long and three inches apart. He starts above the trochanter and one inch behind. His incision extends two inches below the top of the trochanter. The trochanter should be in the centre of the U. This will give a piece of fascia lata four inches wide and five inches long to use as a flap. The anterior portion of the U starts two inches below and one inch anterior to the trochanter and extends up five inches in a straight line to the anterior superior spine of the ilium. The skin and fat and fascia are retracted upward, exposing the trochanter, the top of which is removed with its muscles attached, the operator being careful not to weaken the attachment of the neck in removing the top of the trochanter.

Fig. 44.—Anterior U-incision, from below the anterior superior spine downward just outside the artery, then outward and upward along the trochanter. Brackett.

23. Anterior U-Incision (see figures 44, 45).—Dr. Brackett recommends the use of a U-shaped incision; the inner incision extends downward from just below the anterior superior spine five inches, keeping just external to the artery, then three to four inches across the leg and five inches upward anterior to the trochanter. The sartorius is recognized and retracted inward, with the rectus, the tensor fascia femoris outward.

Fig. 45.—Side view of U-shaped incision. (See figure 44.)

24. Internal Lateral Incision. Adductor Incision for Exposure of the Hip.—The hip is flexed ninety degrees, abducted ninety degrees and outwardly rotated ninety degrees. An incision five inches long is then made along the border of the adductor longus. The adductor longus is retracted inward and the pectineus outward. This incision is sometimes recommended in dislocations as it is the most direct route to the ilio femoral

ligament which is often the obstacle preventing a successful reduction of the dislocation.

25. Arthrotomy for Fractures About the Hip.—The necessity of immediate operation in fracture about the joints depends, as in other fractures, on the acuteness of the local and general reaction. When these do not contra indicate immediate operation, certain fractures about the joint may require treatment by the open method. Among these are fractures of the patella, fracture of the olecranon, certain fractures of the surgical neck of the humerus, and certain fractures of the neck of the femur, all compound fractures, even when the protrusion of the bone has been extremely slight, all fractures that cannot be maintained, or where apposition is impossible, many fractures combined with dislocation, articular fractures with pieces locking or limiting the joint action. See figures 67 to 70.

Where there is a great deal of trauma and in multiple fractures and in cases where there is a great deal of shock all that can be done is to immobilize the parts until a favorable time for operation. In selecting a suitable time for operation the surgeon must remember that when it is found necessary to operate on a fracture if there is no immediate contra indication, the sooner it is done the better. Where there is tremendous swelling the surgeon should always wait. All cases should be operated on that show no union after three months of good treatment.

Methods of treating the individual fracture cannot be considered in a limited space like this. The writer has described the routes of approach to the different joints and the technique of these. This will enable the surgeon from his knowledge of fractures to select the route best adapted for the individual treatment required and when necessary two or more incisions may be used. A knowledge of the technique will enable the surgeon to work rapidly in reaching the fracture on which he expects to spend time.

26. A Method of Treating Overlapping Fractures.—Where the bones overlap, an excellent method of treatment is one suggested to the writer many years ago by Dr. Edward Martin of Philadelphia. In the operation when the surgeon has reached the fracture the ends are freed. A tough tape or webbing is used ten or twelve feet long and is sterilized. The two ends of the tape are tied together, a loop of the tape is placed over the distal end of the bone. The other end of the tape is thrown over the foot of the operating table, a thirty-five pound weight is attached to this by an assistant. In about five minutes the bones will be found to be separated at least one inch. The weight is then held up by a non-sterile assistant, the tape taken off of the end of the bone and clamped to the sheet on the operating table, so that it will not slip away while the surgeon works on the fracture. When the muscles are in fairly good tone or the overlapping of bone has been great, it will be found that the bones will overlap again in four or five minutes. A reapplication of the tape will separate the bones again for the same

length of time. The end of the lower bone should not be cut or freshened until all other procedures are done which require separation of the bone. When these have all been done the end of the bone over which the tape has been placed is freshened. After this the tape should not be placed on the end of the bone, but the two ends allowed to come together and held by a clamp until the operation is complete.

Very bad overlapping fractures have been treated in this way in fresh cases without the necessity of shortening the bone. In old fractures no more bone need be removed than is required by the conical condition of the ends of the bone.

27. Fractures of Long Standing Still Ununited or United with Deformity, Preventing Function.—In fractures of long standing where there is a mild infection, conservative treatment should be tried first. When this has been tried free drainage should be established and at the same time the ends of the bone freshened up slightly. Unless the infection is marked, in many of these cases when the suppuration disappears, union has also taken place. In any case where there has been infection, no plastic operation should be performed until infection has been entirely absent for at least nine months; a year is safer. Where the infection is very mild and of long standing, during the process of treatment the patient may be allowed to walk on the other leg if the local reaction is not too great. Sometimes he may walk a little on the affected leg. It is of advantage in certain cases to use a Thomas knee splint to take some of the weight off of the affected leg, the patient being allowed to bear weight on the ball of the foot, the splint taking all the weight off of the heel. Where the x-ray shows conical ends of the bone it is practically useless to expect union without surgical interference. The Carrell-Dakin technique is advisable in infected cases. See section 323.

28. Fractures of the Neck of the Femur in the Young or Middle Aged.—In recent fractures of the neck of the femur, Dr. Whitman's technique is most satisfactory. Under anæsthesia, manual or mechanical traction is applied to both legs. The good leg is abducted to determine the amount of abduction possible. The fractured leg is pulled on and abducted while the surgeon presses on the trochanter, reducing the deformity and guiding the leg into extreme abduction and hyperextension, and outward rotation is also corrected. A plaster of paris bandage is applied to the thorax, pelvis, thigh, leg and foot holding the hip in extreme hyperextension and extreme abduction; it should fit well. (See application of plaster for the hip and thorax.) A Bradford frame is used under the plaster. A well fitting plaster enables the patient to be moved after the first five days without disturbing the fracture. The bed may be lifted at the head to relieve any tendency to hypostatic congestion. The leg of the plaster rests off of the bed as described for plaster following osteotomy at the hip. The patient may be put on a bed rest at the end of two weeks, if necessary, the well leg remains on the bed; the leg in plaster is off of the side of the bed. The after treat-

ment is otherwise the same as for osteotomy at the hip. The age of the patient must be considered. The results are very excellent. However, in the very feeble it may take one year before the patient is able to walk well, but then it is due to feebleness rather than lack of function. The hyperextension of the hip, the reduction of the deformity, the extreme abduction and correction of the outward rotation will favor good function. In cases with osteoarthritis there is some danger of stiffness with any fracture. Fractures of the neck may be adjusted and nailed or bone pegged. In the old, the fracture is often impacted and should be disturbed as little as possible. The danger from pneumonia or hypostatic congestion is worse than the fracture. In younger subjects, an incision is made and the fracture adjusted. See figures 59 to 62. Traction on the trochanter is made as described for overlapping fractures and the head and neck pegged, nailed, wired or grafted. The trochanter and neck are drilled and a tight prepared bone or other peg driven into the hole made by a drill the size of the peg and if possible tapered so that it may be driven tight.* The patient is put up in a long plaster spica from the nipple line to the toe and immobilized in bed for four to five weeks, and then gotten up with crutches and the spica cut off below the knee. Old fractures of the neck with an excursion of the trochanter may be adjusted by pulling down the leg as far as possible, then cutting the trochanter to fit the head or the denuded acetabulum. This gives a firm hip sometimes with forty to eighty degrees of motion, sometimes very little motion. Walking is, however, much improved and later the other leg may be shortened if the difference is great (see paragraph 42). It should be remembered as pointed out by Whitman that full abduction and hyperextension is the best position for a recent fracture of the neck.

29. Coxa Vara. Operation.—In operations for Coxa Vara, an anterior or antero-lateral incision may be used unless a trochanteric operation is decided upon. This latter operation is the most satisfactory (see Subtrochanteric Osteotomy).

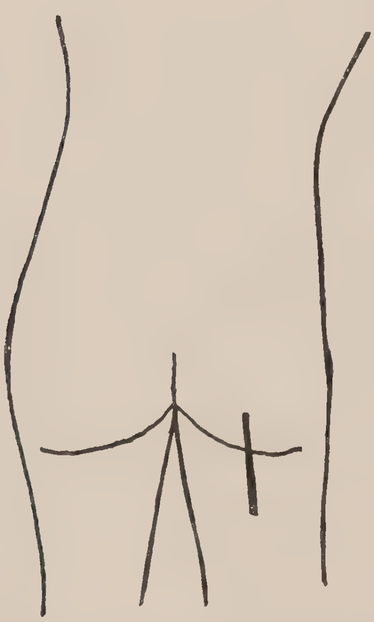

Fig. 46.—Incision for reaching the sciatic nerve.

30. Incision for Exposure of the Sciatic Nerve.—An incision in the median line is made three inches long on the posterior aspect of the thigh beginning at the fold of the buttock dividing the lower fiber of the gluteus maximus and separating the tissues below this muscle by blunt dissection. The sciatic nerve can be felt with the finger. A full view of the nerve is obtained when the muscles are separated (figure 46).

31. Incision of the Adductor Magnus Tendon in Hip Operations.—In manipulating a dislocated hip or a shortened leg due to

* As described by Hawley.

overlapping fracture of long standing, it is sometimes necessary in addition to having a traction machine and in addition to the operation on the joint or the fracture, to gain length in the adductor magnus by a tenotomy of the tendon just above the internal condyle.

The tendon may be felt here. An incision is made three-fourths of an inch long, the finger readily recognizes it, a director hooks it up and its fibers tenotomized directly across or by an oblique or zig-zag tenotomy. One suture will close the incision. It is sometimes surprising the relief of tension obtained by this procedure (see figure 47).

32. Operation for Gluteal Bursitis (see figure 48).—An incision is made three inches long over the great trochanter through the skin and

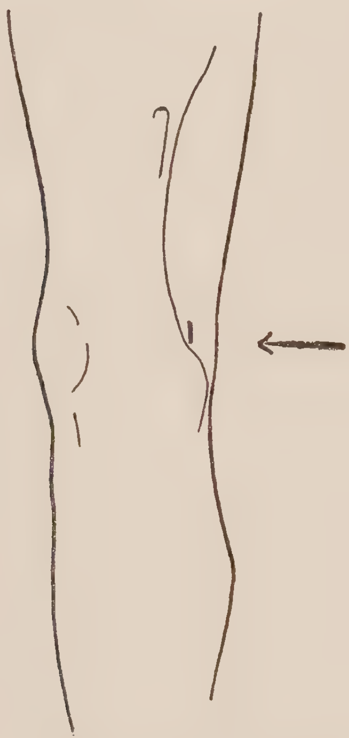

FIG. 47.—Adductor magnus incision. Incision three-fourths of an inch long. Here the tendon can be hooked up and tenotomized.

FIG. 48.—Incision for reaching the gluteal bursa.

fat parallel to the femur. This is the most convenient incision for gluteal bursitis. The fascial portion of the gluteus maximus is raised and the bursa will be found under it. The bursa may be dissected out or incised and drained.

33. Tapping the Hip Joint.—The most scrupulous aseptic precautions are necessary both as to the preparation, and the protection, of the field of the operation.

The trocar may be thrust just above the great trochanter from the side of the patient directly inward or the joint may be reached from the front external to the sartorius at the same level (see figures 49, 50). When the head or neck is reached the sharp point of the trocar may be withdrawn and the dull end used as a probe to locate the exact point

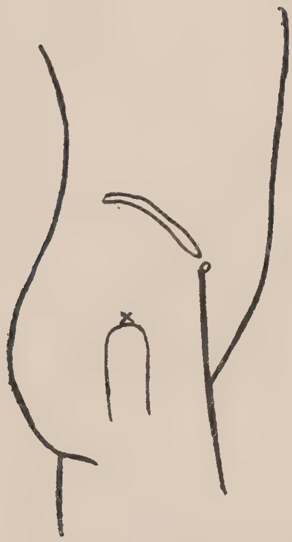

Fig. 49.—Tapping the hip from the side.

before using the trocar point again. The neck is reached easily and then the head, further inward. The trocar point is then inserted and the joint tapped.

When there is much effusion it is not difficult to reach the joint. The skin is drawn to the side so that the hole in the skin and muscle will be out of line when the needle is removed. If fluid is to be withdrawn, and other solutions are to replace it, the amounts should be carefully measured. Two good graduated metal syringes are very useful. All of their parts should be tested beforehand. The trocar is made to enter the joint and then is connected with the syringe. As little air as possible should enter the joint. The trocar should be of large diameter as the fluid may be thick or flaky. When the patient is not anæsthetized for the operation it is often well to have a short flexible tube connect the trocar with the syringe. This should be fastened at both sides by silk ties so that it will not leak easily when pressure or suction is used. If the joint is to be washed out a definite amount of fluid is injected and the return measured in a sterilized measuring glass.

Fig. 50.—Tapping the hip, just outside the sartorius at a point one-half way between the top of the trochanter and the artery, at Pouparts ligament.

Dr. Murphy uses a formalin glycerine solution as follows:—

Liquor formaldehyde, 2% in glycerine, about ten drops of the formaldehyde to each ounce of glycerine. This acts very well in infectious synovitis. But it should not be used in arthritis deformans nor in old chronic arthritis. The tapping may be done with ethyl chlorid or novocaine adreneline solution, 1%. The solution should be prepared twenty-four hours before it is used (Murphy).

CHAPTER V

OPERATIVE TREATMENT IN CASES OF HIP-JOINT ANKYLOSIS

34. Principle of Arthroplasty for Ankylosis of the Hip.—Ankylosis may be bony, cartilaginous or fibrous, it may be periarticular, ligamentous and capsular, or extra articular, that is, skin scars, tendons, fascia, nerves and arteries.

The form of ankylosis that exists will determine the treatment. A partial ankylosis at certain points had better not be treated by an arthroplasty.

Age must be considered, also the general condition of the patient. When the ankylosis is bony, cartilaginous or fibrous, arthroplasty is indicated. When the condition is periarticular or extra articular, it may be treated by capsulotomy, tendon elongation, excision of exostoses, etc.

Dr. Murphy lays stress on the following points: The principles of asepsis to the finest detail are absolutely essential. One not familiar with the best surgical technique should avoid arthroplastic operations. The exposure of the joint must be generous and careful. The excision of the ankylosis must be complete. The contracted capsular ligaments and soft parts must be freed and if necessary lengthened. The normal contour of the joint should be restored as near as possible. The operator should obtain a hyper-mobilization of the joint. The joint should be re-shaped to give stability. The inter-position of material to prevent reunion of the bone is necessary. The principle is to separate the bones and to interpose between them material to prevent ankylosis. The best material for this purpose is the human pedicle, composed of fat, muscle, fascia, or a combination of these.

When this is not possible, a transplantation is made of fat and fascia from the trochanter bursa region or from the fascia lata.

Material such as ivory, celluloid, silver are *not* good. Materials that will not absorb or that absorb too slowly are not desirable.

During the operation the soft parts should be freely liberated. Attach the interposing flap to one bone only and cover it completely. Early motion, that is, at the end of five to seven days is necessary with or without gas or gas oxygen.

Dr. Murphy records failures in arthroplasty as due to first, insufficient and defective exsection of the capsule and ligaments, second, insufficient interposition of fat and fascia between the separated bony surfaces, third, infection, fourth, the sensitiveness to pain on motion after operation.

Cases of primary tuberculosis and cases of recent infection that have

subsided are not suitable cases for arthroplasty. In operating, in addition to the usual protection of the field of operation, after the skin and fat have been incised, towels should be clamped to the edges of the skin.

35. Technique of Arthroplasty at the Hip.—Dr. Murphy recommends a U-shaped incision for Arthroplasty at the hip the sides of which are about five inches long and three inches apart. He starts one and one-half inches above the trochanter and one inch behind. The incision extends two inches below the top of the trochanter. The trochanter should be in the centre of the U. This will give a piece of fascia lata four inches wide and five inches long for use as a flap. The anterior portion of the U starts one inch below and one inch anterior to the trochanter and extends up five inches in a straight line to the anterior superior spine of the ilium. The skin and fat and fascia are retracted upward, exposing the trochanter, the top of which is removed with its muscles attached, the operator being careful not to weaken the attachment of the neck in removing the top of the trochanter. A large heavy needle threaded with silk is passed behind the top of the trochanter; to the silk is attached a chain saw. This is used to remove the top of the trochanter, the obturator and pyriformis muscles are detached and retracted. The capsule is separated subperiosteally from the neck of the femur, a number of silk sutures with long ends are placed in the capsule so that it may be easily recognized later on. The long ends are attached to clamps which help to hold the capsule retracted. The capsule should remain attached to the acetabulum. A curved chisel is used to separate the head from the acetabulum following the normal outlines of the joint, and extending inward one inch between the bones all around.

Dr. Murphy's globular drill and cup-shaped endmill will smooth out the cavity and make a round shaped head of the femur. The flap of fascia and fat taken from under the skin are now placed inward and sutured to the remnant of the capsular ligament or may be covered over the whole head and neck of the femur. After replacing the head in the acetabulum, the capsule is sutured, the trochanter is replaced, the separated obturator and pyriformis muscles are reattached. An eight or six pennyweight nail is used to hold the trochanter in place. The muscles are brought together with interrupted chronic catgut sutures number 00, the fat with interrupted chromic catgut sutures number 00, the skin with continuous chromic catgut sutures number 00. Buck's extension apparatus is applied with twenty pounds' weight holding the leg in an abducted position. The patient is kept in bed for seven to ten days with this apparatus. After this, passive motion in flexion is introduced depending on the amount of pain or motion. The passive motion is used daily. Lateral motions are begun later on. A removable splint or plaster is applied for three or four weeks and removed when a fair degree of motion is possible without pain or great discomfort. The patient is then allowed to get up with crutches and swing the leg.

36. Operation for Deformity at the Hip with Joint Ankylosis. Hip Flexion and Adduction with or without Dislocation of the Hip. Operation for Coxa Vara.—Where the tissues have been contracted about the hip over a long period of time and the hip not dislocated, there is sometimes a fibrous ankylosis at the hip which maintains the position of deformity even after an operation is done to relieve the contracture of the soft tissues. Often after dislocation a practical ankylosis exists. Where this ankylosis is very slight and not due to previous tuberculosis it is advisable to limber up the hip joint by manipulation as described in these pages elsewhere. When the ankylosis amounts practically to an arthrodesis or when an arthrodesis has been done and deformity of flexion and adduction have developed, it is often advisable to do a Gaunt or subtrochanteric osteotomy and correct the deformity. Even when walking is possible with a flexed and adducted hip, there is a tremendous expenditure of energy due to the awkward and back straining position; with this position there is often pain in the hip and back which eventually makes locomotion impossible. These conditions are relieved by straightening the leg and should not be left till the patient is disabled. When deformity and ankylosis exists the operation of choice is an osteotomy. See figures 494 to 496.

Fig. 51.—Diagrammatic cross section of bone. Shows inclination of the osteotome when cutting the anterior bone surface and method of holding it inclined anteriorly.

Fig. 52.—Shows the method of cutting the bone in sections on the anterior surface.

37. Subtrochanteric Osteotomy, " Gant."—When under anæsthesia (for operation on the right hip) the patient is placed on the left side, the left hip and knee being flexed to add stability to the position. Sand bags and pillows are arranged about the chest to prevent the patient from rolling. The operator stands behind the patient, the skin being prepared and the operative field protected. The osteotome is introduced over the outer side of the trochanter subcutaneously with the blade parallel to the line of the femur about one or one and one-half inches below the top of the trochanter. When the periosteum is felt with the cutting edge of the osteotome, the blade is turned so that it lies across the bone. The bone is cut across slightly obliquely from without inward and downward, the operator cutting and then feeling, using the osteotome as a probe, then cutting what he feels with the osteotome. An open incision is of no advantage. The

Fig. 53.—Shows further cutting of the bone surface (sections three, four and five will be cut in succession).

bone is cut through on its anterior surface inward, then another portion is cut posterior to this, working from without inward, and so on backward until the bone is entirely cut (figures 57, 59). When the bone is cut through this can be determined by feeling with the osteotome, an assistant lifting the leg and gently abducting or rotating the femur. Crepitus is felt when the bone is completely cut through. If a very little remains to be cut it will break readily as the femur is abducted and rotated. When the osteotome is withdrawn, no sutures are necessary. A sterile sheet wadding pad is placed over the small wound. The patient is placed on a traction machine after cutting the bone but preferably for the whole operation (see figures 54 to 59), and both legs pulled evenly so that the perineum rests firmly against the perineal rods. The left leg is tightened and then the right, the muscles being stretched down until good length is maintained in the short leg and about forty degrees of abduction with twenty-five degrees of hyperextension at the hip. This position is regulated and held by the traction apparatus during the application of the plaster, which should reach from the axilla to the tip of the toe of the affected leg. For 12 years the writer has used the apparatus illustrated here. Where a Hawley Table is available this should be used. The plaster extends a short distance down the opposite leg, and should maintain the hip operated on in an abducted position of forty-five degrees and hyperextended twenty-five degrees. When the plaster is completed a

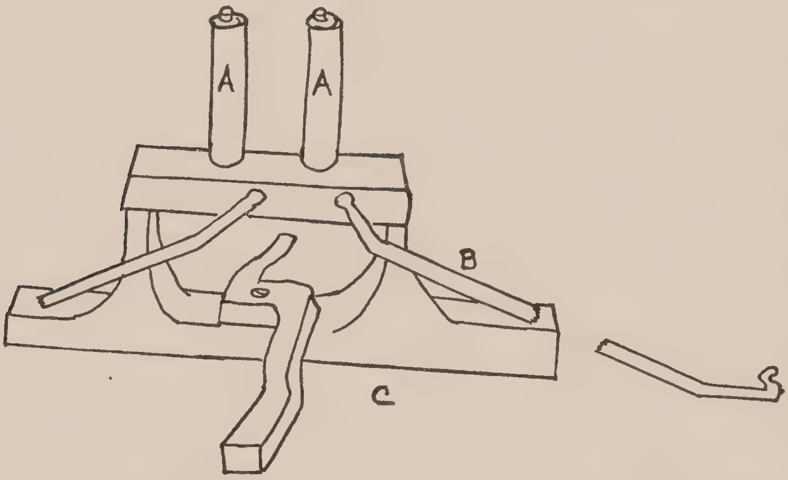

Fig. 54.—Traction machine for operation on the hip or femur holding the patient ready for plaster without change of position. Traction rods in place. A, Rollers against tuberosity of the ischium. B, Traction rod. Two like this. C, Stand to hold pelvis off of the table.

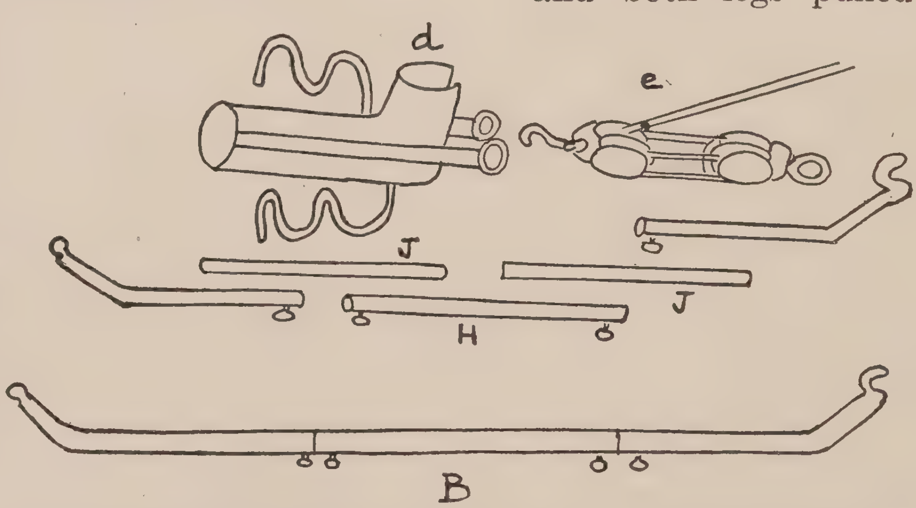

Fig. 55.—Traction machine parts. D, Leggings. Two like this. E, Pulleys. Two sets of double block pulleys. H, Disjointed traction rods. B, with thumb screws to hold inside rods. J, Rods that fit inside the traction rods. The stand for the thorax is similar to (C) only broader.

window is cut over the abdomen and the plaster is removed from the back of the thorax down to the lumbar region and from the side

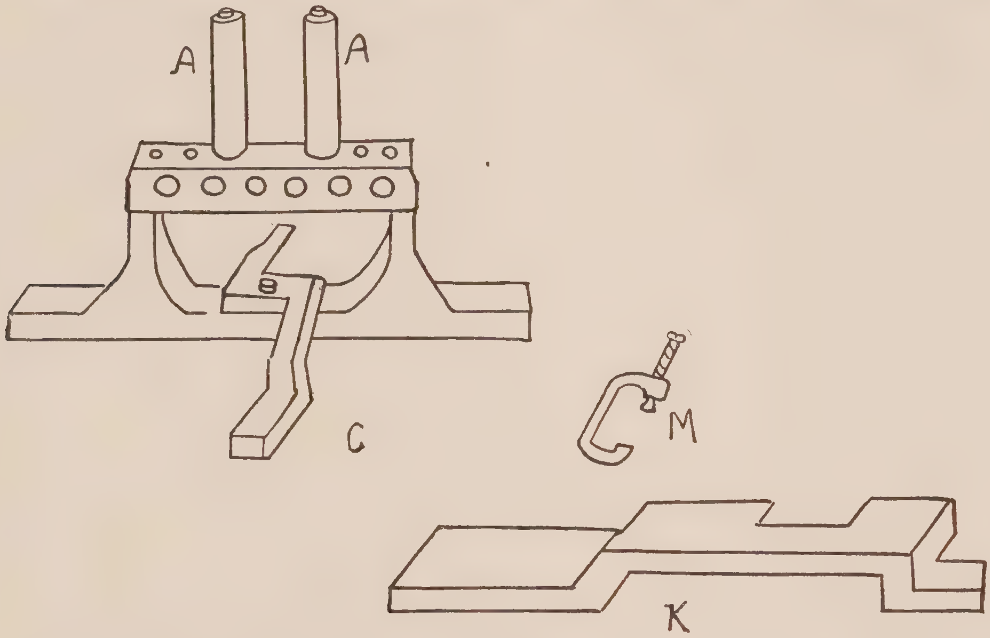

Fig. 56.—Traction machine for operation on the hip holding the patient ready for plaster without change of position. A, Rollers against tuberosity of the ischium. C, Stand to hold the pelvis off of the table. K, Extension used to clamp thorax and to clamp pelvic stand to table. There are four extension clamps like (K).

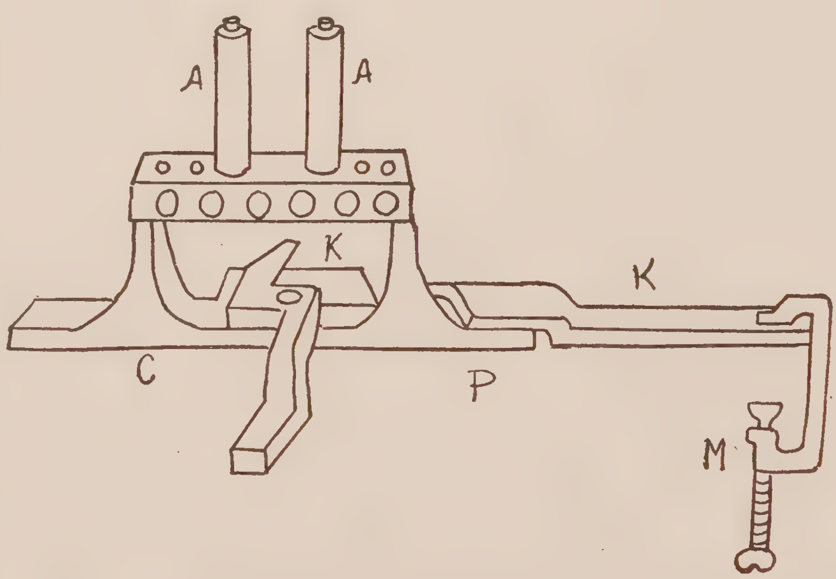

Fig. 57.—Traction machine for operations on the hip holding the patient ready for plaster without change of position, clamps holding it firmly to the table. A, Rollers against tuberosity of the ischium. C, Stand to hold pelvis off of the table. K, Extension used to clamp thorax stand and to clamp pelvic stand to table. M, Clamp. There are four like this. P, Shows extension clamping pelvic piece to table.

operated on as far as the crest of the ilium (see figures 25 to 29). This allows abduction and hyperextension but not the reverse. The surgeon can assure himself of the abducted position by feeling the anterior spines when the plaster is still soft, and as soon as the plaster is cut out he may put his hand through the window in the abdominal portion of the plaster and ascertain the position of the anterior superior spines in order to be certain that the abducted position has been maintained. The patient and plaster are placed on a Bradford frame and handled and moved on the frame. The patient is kept on his back for six weeks, after that he sits up in the

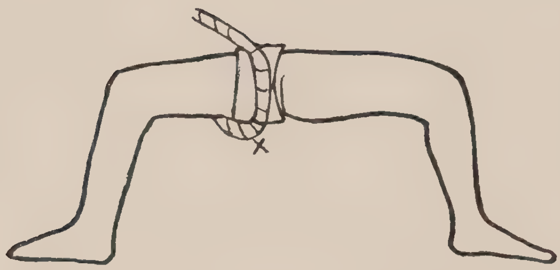

FIG. 58.—To prevent slipping of the plaster. Method of applying plaster to tuberosity of the ischium by a plaster rope (X) over felt padding, using traction machine (see figure 57).

plaster, on the edge of the bed, keeping the good leg in the bed, bending the good hip. In four days more he is allowed to stand on the good leg and encouraged to walk as soon as his strength allows. When he is able to keep his equilibrium for fifteen minutes a lighter plaster is applied holding the pelvis and the leg above the knee. Walking is encouraged on the operated leg in the seventh week. A leather spica should be used for about a year to prevent adduction.

CURVED OSTEOTOMY AT THE BASE OF THE TROCHANTER

Dr. Brackett's Modification

Instead of doing an oblique osteotomy, Dr. Hoffa and Dr. Brackett make an open incision anteriorly cutting the bone in a curve from

FIG. 59.—Shows rope (X) pulled towards patient's shoulder.

within outward and slide the bone in this curve into an abducted position.

Removal of a Wedge of Bone

If the operator prefers he may remove a wedge of bone from the femur, close the gap and cause abduction and hyperextension. The bone may be sutured or wired or an inlay bone graft used after osteotomy. In the majority of cases a simple osteotomy is as good as any of the elaborate methods. In any event the result will depend on gaining and maintaining the position by an adequate well fitting plaster of Paris bandage.

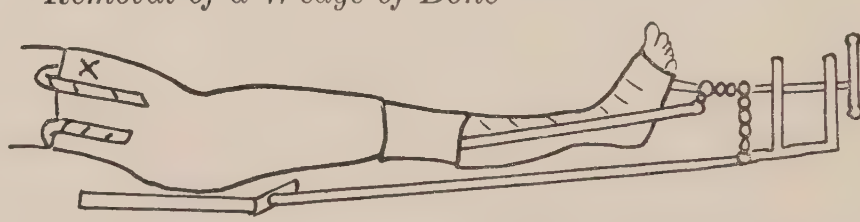

FIG. 60.—Shows the plaster applied over rope (X) and the ends turned down holding the pressure on the tuberosity of the ischium.

FIG. 61.—Represents the next stage with the plaster rope (X) buried in the plaster.

The reader is referred to other pages for the detail in applying a plaster of Paris after hip operations (see section 10). A good traction machine and a well applied plaster are essential for the best results after osteotomies whenever extreme deformity at the hip exists.

38. Operation for Coxa Vara with Ankylosis.—A subtrochanteric osteotomy as described above is the simplest and an effective way of correcting coxa vara. The removal of a wedge of bone from the trochanter is more complicated and rarely necessary.

The after treatment is the same as in osteotomy at the trochanter.

39. Osteotomy at the Neck of the Femur.—Osteotomy at the neck of the femur to correct deformity here or for coxa vara is sometimes indicated. The neck is reached through an antero-lateral incision from the anterior spine to the top of the trochanter and then extending downward two or three inches along the front of the trochanter. The gluteus medius and tensor fascia femoris are separated and the neck is easily reached. A drill may be passed through the head of the femur and another through the trochanter. These are placed firmly in the bone and should be placed parallel to each other. The neck is cut with an osteotome and the leg put in the desired position. This operation should be done with the patient on a traction machine so that there will not be any over riding of the fragments. If necessary a bone peg is passed through the trochanter neck and head of the bone after correcting the deformity, the drill ends are now used to guide the position of the head and hold it into place while applying the bone graft or wire nail. The drill should be a little smaller than the nail or graft or a tapered bone peg may be used as suggested by Dr. Hawley.

In most cases of deformity of the neck, an osteotomy through the trochanter will give the same result as to correction and will have the advantage of simplicity, also the bone is thick and heavy here, making good repair an assured factor. The operation is some distance from the joint so that it will be injured as little as possible.

This operation should be done with a traction apparatus as described in these cases.

The after treatment for osteotomy through the neck is the same as for osteotomy through the trochanter.

40. Albee Hip Operation in Osteo-arthritis for the Relief of Pain. Arthrodesis.—In osteo-arthritis at the hip, Dr. Albee has suggested a method of obtaining ankylosis by a partial excision in situ. This operation is especially adapted to the adult arthritic case with severe pain and in no instance should it be used where there is active disease or when there has been tuberculosis or suppurative joint disease.

An antero-lateral incision is made, the head exposed, but not dislocated, its upper and inner surface chiselled away (see figures 39 to 44) in situ, also the upper surface of the acetabulum removing a quadrilateral piece of bone partly from the head and partly from the upper acetabulum. When this space closes the bone should be

cut in such a way that the leg abducts, correcting any deformity in flexion or adduction. The operation may be done rapidly and the patient allowed up in two weeks with a protective splint, or plaster if the hip is sensitive. In order that motion of the hip may not return, activity of the patient but not of the hip is encouraged as early as possible. Weight bearing is allowed at the end of the fourth week. The activity of the patient is important as the operation is rarely necessary in those

Fig. 62.—Dr. Albee's operation outline of bone to be removed from acetabulum and head of the femur.

Fig. 63.—Bone removed allowing abduction and full extension when the bony surfaces come together.

Fig. 64. — Position favoring ankylosis.

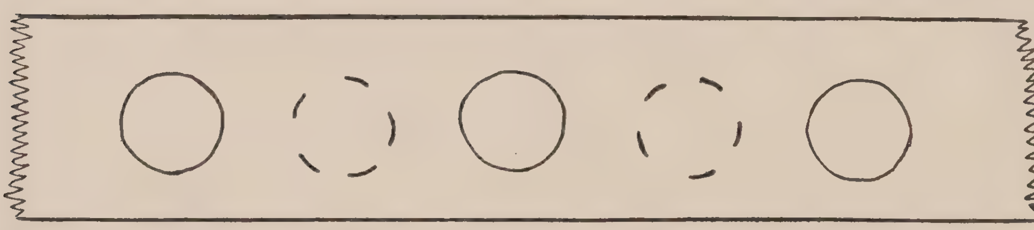

Fig. 65.—Method of drilling the bone on either side. The dotted lines represent drill holes on the other side.

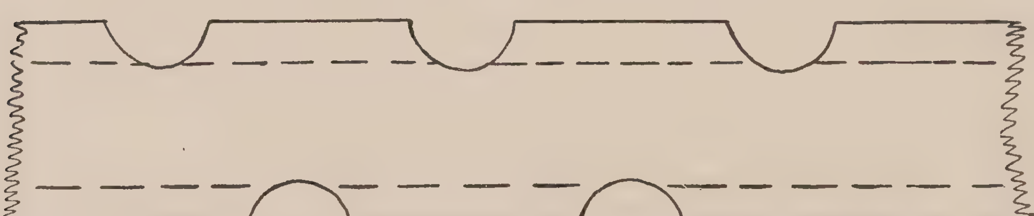

Fig. 66.—Side view showing method of drilling the bone alternately on one side and the other.

under fifty years of age, and then only as a means of relieving pain by causing ankylosis in a favorable position. See figures 62, 63, 64.

41. Operation for Separation of the Epiphysis at the Hip.—In separation of the head at the epiphysed line, the antero-lateral incision is the easiest method of approach when operation is indicated.

In fractures of the neck or intra capsular fractures when operation is indicated, the antero-lateral incision is the most satisfactory. It may be necessary in these cases to insert a drill in the head of the bone and use the drill tip as a handle to control it while the fragments are

being adjusted. A bone graft or a peg or a long nail may be used to fix the fracture. See section 28.

42. Adjusting Legs of Unequal Length.—When the legs are very unequal in length, the longer leg may be shortened.

An incision four inches long is made laterally or anteriorally, separating the fibers of the muscles and exposing the femur at about its middle. The bone to be removed is marked above and below allowing the leg to be three-eighths or one-half inches longer than its fellow. The bone is cut with a Gigli saw or a sharp osteotome; the latter method requires less exposure and less disturbance of the tissues.

The femur is cut through, then each end is brought out of the wound and sawed, the amount removed from each end carefully, measured by a sterile steel ruler. The bone sawed straight; or one end sawed wedge-shaped and the other like an inverted wedge to fit it; or each end may be cut like a long step so that they overlap and are held by a bone screw, suggested by Gallie, the bone drilled with a screw tap, which corresponds to the screw. A number 14 screw tap and screw are used. The bone is adjusted and sutures placed; coaptation splints are applied over sterile sheet wadding and a long plaster of Paris applied over this. The patient is kept in bed four or five weeks and is allowed to walk on the plaster, after that with crutches. When walking is easy the plaster is gradually omitted.

CHAPTER VI

OPERATIONS IN SUPPURATIVE CONDITIONS ABOUT THE HIP

43. Suppurative Conditions at the Hip Joint.—In suppurative conditions at the hip joint an anterior incision may be used. If the disease is extensive or very acute this should be combined with an anterior lateral incision and a posterior. A single incision is rarely enough.

Tubes are placed to the joint from each incision; gauze is used to gap the corners and make them round.

When the acetabulum is extensively diseased and the condition is progressively growing worse, the head should be dislocated and the acetabulum drained and a large opening made through it. The bone anterior to the acetabulum below the anterior spine may be chiselled away with the softened diseased parts of the acetabulum. While this may be indicated in adults, in children the worse cases of bone disease will often recover in time, following good drainage and without radical measures applied to the bone. In all cases good drainage should be established first and any radical measures applied to the bone should be reserved for those cases where good drainage is not sufficient. See section 323, Carrell-Dakin technique.

44. Excision of the Hip in Suppurative Conditions.—The hip is approached as described for arthrodesis (see section 12). The amount of bone to be removed will depend on the amount of disease present.

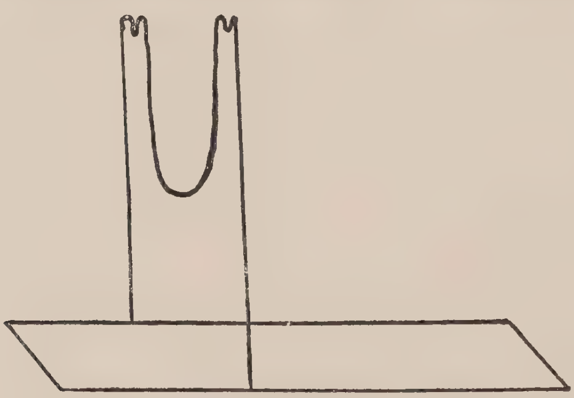

FIG. 67.—Heavy bent wire frame. Wire splint for fracture of the femur in infants. The frame is covered with canvas as described for the Bradford frame. The head and body rest on this. Diapers are placed under the hips. Traction is applied to the legs lifting the hips very slightly off of the frame as shown in figure 68.

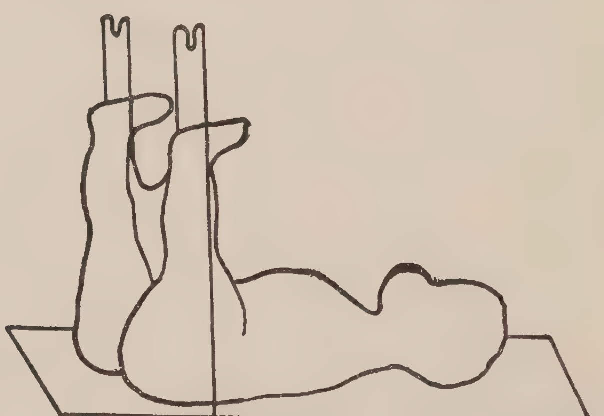

FIG. 68.—Showing patient in position.

45. Methods and Principles of Drainage in Acute Non-tubercular Suppurative Joint Disease. Hip.—A small suppurative focus without virulence or active constitutional disturbance should be drained by a suitable incision, wiped out with gauze, a tube placed to its deepest part and the soft tissues gaped with gauze.

When there is a great deal of constitutional disturbance drainage and counter drainage should always be the rule; if the bone is involved this should be opened and counter opened as shown (figures 65, 66). The pus cavities in the soft tissues should be wiped out. No extensive bone operation should be done otherwise. The bone should be drained with tubes to the remote portions and the muscle, fat, and skin gaped by

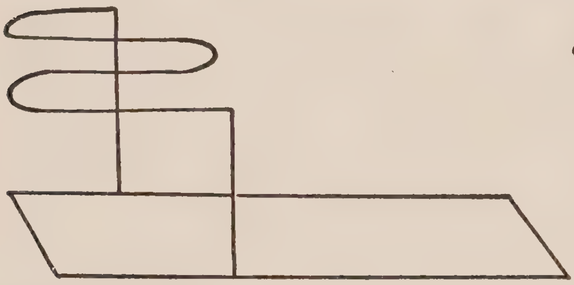

FIG. 69.—Heavy bent wire frame holding the knees flexed.

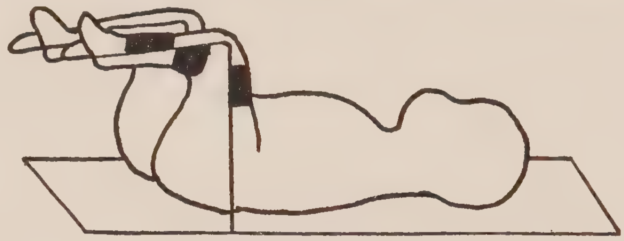

FIG. 70.—Bent wire frame for fracture of the femur in infants. The frame is made as described in 67. The leg wires are bent at the knee, three to five inches beyond the flexed knee. Two soft folded towels (represented in black) one for each leg are placed behind the upper third of the tibia and fastened to the frame lifting the hips off of the frame. A third and fourth soft folded towel is placed over the front of the lower third of each tibia to steady the leg and help hold the hips off of the frame. A fifth and sixth soft towel is placed above the knee and fastened to the frame. The towels are marked in black.

gauze. These operations are done quickly and should not be prolonged, but efficient drainage and counter drainage should be established unhesitatingly. It is rarely necessary to do more at this time. If there is a marked sequestra formation this should be removed, but this had better not be done at the time of instituting drainage when the patient is nearly exhausted from an acute process. Any future operation made necessary should give good drainage and the removal of the sequestra if separated.

Any extensive non-tubercular suppurative bone disease about the hip should be drained by an antero-lateral and a posterior incision or by an anterior and a posterior or by all three. If the patient is very ill and the abscess not easily located an anterior, an antero-lateral and a posterior incision should be made very rapidly and good drainage established. The anterior is usually the last to close, in spite of the more dependent positions of the other two.

In very ill cases the operation should be rapid with short anæsthesia but in these cases large incisions and always counter incisions should be insisted upon. Excision and removal of parts of the bone may be done later.

Any chronic suppurating process should be well drained and counter drained, the pockets in the tissues well opened and wiped out and the diseased bone well drained. Large incisions should be made with tubes to all dependent parts and large gauze pads used gaping the wounds for at least ten days; after that the tubes and wicks are shortened. This method of treatment is usually very successful. It does not necessitate the constant reapplication of drains, so discomforting to the patient. Irrigations should not be used in the after treatment. The gauze should

be placed around rather than over the wounds. The hip is held fixed by placing the patient on a Bradford frame with traction or by means of a plaster of Paris bandage or an old-fashioned Thomas hip splint. It should always be immobilized. See Carrell-Dakin Technique, section 323.

46. Acute Arthritis of Infancy.—The incision for drainage in acute arthritis of infancy is the antero-lateral incision without its second part. As soon as it is possible to make a diagnosis, an incision should be made down to the capsule in which a very minute incision is made and a tube introduced. Immediate drainage is all that is necessary in this condition. This will relieve the tension in the capsule and render spontaneous dislocation unlikely. For tenderness or swelling of the hip due to suppurative condition, following middle ear disease, scarlet fever or other acute infections, drainage is indicated as soon as a diagnosis can be made.

Immobilization by sand bags with the patient on a Bradford frame is all that is necessary. In a few cases a wire splint may be used as shown in figures 68 to 70.

47. Osteomyelitis.—In osteomyelitis an operation should be done as early as possible after making the diagnosis. In sub-acute cases, incision and drainage is all that is necessary. Whenever incising for abscess, all the pockets should be opened and if the abscess is large, counter incisions are made at dependent portions. The pus pockets should be opened freely, wiped out with gauze, irrigated and wiped out again with gauze. Curetting should be avoided excepting for the removal of sinuses in the skin. In cases with sinuses it is often better to excise them. Perforated rubber tubing should be placed to drain the deepest portion of each pocket. The skin, fat and superficial muscle layers should be made to gap by means of gauze drains. At the end of ten days the gauze is removed and the tubes shortened. The tubes are gradually drawn out a little each day, or two, until not used. This method makes the repeated reapplication of drains and wicks unnecessary as the wound will gap of itself and close from the bottom if the surgeon has been careful to make large incisions.

Where the periosteum is found destroyed or the pus under the periosteal layer, the bone should be opened by means of a large drill or a small gouge. Where this is necessary, the incisions should be large and a counter incision should be made on the other side of the bone with a hole made in the bone a little above or a little below the hole on the opposite side (figure 65). These holes in the bone should open up the medullary cavity. They should alternate on one side and the other as far up and down as the disease is suspected. When the abscess is very great and the bone involvement is large a number of good size holes should be made with a Burr drill or a curved gouge on both sides of the bone as shown in figure 66. The wound should be gaped widely;—the skin, fat and superficial muscle held wide open by large gauze drains. The tubes should reach from the surface to the deepest portions of the

abscess cavity. Splints should always be applied to immobilize the limb. They should be placed so that they will not interfere with the dressing. In some instances it is better to apply the plaster with large windows and ropes or to use a Bradford frame and traction to give stability as shown in figure 453. The dressings should be done every day or twice a day, depending on the foul condition of the discharge. If the odor is excessive chlorinated soda dressing should be used diluted, $^1/_2$, $^1/_3$ or $^1/_4$ U. S. P. strength. The gauze drains should remain for at least ten days without being disturbed. When removed granulations will be formed under them in such a way as to keep the wound open without applying drains. Irrigation may be used at the time of the operation and the wound thoroughly wiped out with gauze afterwards. No irrigation or probing or application of wicks will be necessary if the first drains are left in long enough. After the first ten days the tubes are shortened gradually until they are not needed.

In severe cases where the patient is unconscious or delirious the bone should always be opened, three or four holes on either side made with a good size Burr drill or a gauge. In no case should the incision be made on one side of the leg only in severe cases. No tight packing should be used as this interferes with good drainage. Where sequestra have formed they should be removed. An x-ray should be taken whenever possible to determine the position of the disease (unless the case is urgent and an immediate x-ray is not obtainable).

In cases of long standing that are sub-acute at the time of first examination, where the bone is riddled with holes over an extremely long area, it is impossible often to remove the dead bone satisfactorily without removing all the bone. In these cases free incision down to the bone with frequent openings into the bone as described above, will allow the septic process to run its course and the sequestra to gradually separate. We have had some cases in which the lower third of both femora were riddled with holes and full of sequestra, the patient being in no condition for extensive operation, and yet not very ill. In these cases, however, if the surgeon had seen the patient in time an early operation would have prevented this extreme condition.

Sometimes it is necessary to close a large open bone cavity which will not heal over. Where the process is distinctly septic no plastic operation should be done without first doing an operation to eliminate the septic condition. After that, part of the muscle may often be transferred over such a cavity after it is closed. In transferring a muscle over such a cavity it should be freely transplanted and held there without tension. The skin should be brought together over the muscle and the wound drained, as there is apt to be some inflammatory reaction.

Where sequestra are present it is always desirable to remove them as soon as they have separated and the involucrum is strong enough to act as a support. Sequestra may be superficial or in the medullary cavity or both. Where there is a persistent sinus and a sequestrum is present,

pus will continue to form until the sequestrum is removed. Cases discharging several years where a sequestrum is present may close in a few weeks after removal of the sequestrum.

In closing a bone cavity its edges may be chiselled clean, then the bone incised a short distance from one edge and parallel to it, the incision is carried down to the medulla. This incision in the bone is widened by prying it open and forcing the bone together, closing the old cavity. This method of closing an old open bone cavity is sometimes satisfactory. For the treatment of suppurating conditions by the Carrell-Dakin technique, see section 323.

PART II—KNEE

CHAPTER I

OPERATIONS FOR DEFORMITIES OF THE KNEE

48. Operative Manipulation of the Knee.—In manipulation of the knee under anæsthesia the patient should lie on his face with a firm pillow (see figure 71), or sand bag under the lower end of the femur. Where there is very slight flexion of the knee due to contracture of the hamstrings, the operator will grasp the thigh near the tibia with the left hand and just below the middle of the calf with the right. An assistant holds the lower end of the femur and a second assistant steadies the buttock. In order not to break the femur or the tibia, the first assistant should hold the femur below the middle and the manipulator should hold the tibia above its middle. The joint is gently stretched and relaxed, the operator applying force gently in a gradually increasing manner until considerable force is applied and then relaxing until very slight force is used and finally relaxing entirely. A rhythmic extension and flexion is kept up. No rough or forcible extension without a gradually increasing or gradually decreasing force should be employed. In this way a minimum amount of trauma is caused. A joint that at first will seem almost impossible to extend will often give way and straighten.

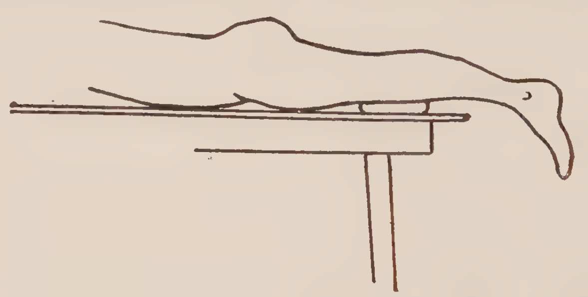

FIG. 71.—Dr. Bradford's position for manipulation of the knee. The knee rests on a pillow.

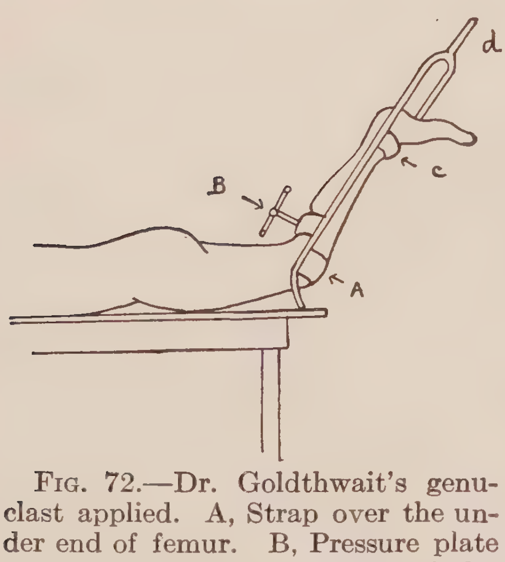

FIG. 72.—Dr. Goldthwait's genuclast applied. A, Strap over the under end of femur. B, Pressure plate at upper end of tibia posteriorly. C, Strap over lower end of tibia anteriorly. D, Lever end.

49. Operation for Flexion Deformity of the Knee.—Permanent flexion of the knee may exist with motion or without motion. When there is no motion the knee is ankylosed in a flexed position. When there is motion and permanent flexion, full extension is impossible. Complete flexion may also be impossible.

The treatment will of course depend on whether the deformity is

easily corrected by gradual stretching under ether or whether these modes of treatment are undesirable because of the condition of previous disease or because of the resistant condition of the flexion. When no previous disease has existed if slight, the flexion is corrected by manipulation. Usually it is not necessary to lengthen or tenotomize the hamstrings (see in the pages tenotomy and myotomy of the hamstrings).

When the condition is resistant or due to previous disease quiescent for a long time, especially if a fair degree of motion exists, an osteotomy and correction of the deformity is a very satisfactory procedure because of its ease and because of the result to the patient. This may be done when the examination and x-ray all show that the deformity is of long standing or was due to a diseased process that has subsided. Even if the motion is not limited by bony ankylosis, much trauma is necessary to forcibly straighten the deformity without osteotomy. The trauma from stretching and tearing will often give much swelling and a stiff knee may result. On the other hand, by an osteotomy all the joint motion present before operation is assured afterward with the leg straight. It is better to do an osteotomy, just above the adductor tubercle and straighten the knee. This is especially indicated if there is good motion in flexion beyond the permanent flexion. The knee should always be hyperextended a little after such an osteotomy. (See section 54.)

In cases with from twenty-five to eighty degrees of permanent flexion with motion beyond this, there will be comparatively little trauma and a very good functional result from this operation. When considerable flexion exists, accompanied by subluxation, then a genuclast is often necessary to obtain the best results (see figure 72).

Fig. 73.—Flexed knee with subluxation of the tibia.

Slight permanent flexion is sometimes due to a curled semilunar cartilage or inflammatory changes due to injury of the cartilage. When this has existed for some time, force should not be used, but the inflammation allowed to subside or the cartilage removed completely as described elsewhere in these pages.

50. Operation.—Tendon Lengthening to Correct Knee Flexion.—When the knee flexion is due entirely to short hamstring muscles these may be lengthened by one of the methods described under tendon lengthening either in the muscular or preferably in the tendonous parts of the muscle, the tendons being split diagonally or by the zig-zag method and sutured. In simple cases careful stretching under ether is all that is required.

When the contracture is due to spastic rigidity of the flexors of the knee it is usually better to tenotomize the tendons by open method. If the contracture is of long standing, careful manipulation with or without genuclast may be necessary. If there is much joint ankylosis an osteotomy low down on the femur may be necessary as described in

these pages. When the tendons are lengthened and this is sufficient, the knee is held slightly hyperextended in plaster for six weeks, after that a caliper is used until locomotion is satisfactory. The caliper is gradually omitted as the leg becomes strong and the surgeon is able to assure himself that no recontracture is taking place.

The muscles should be exercised in flexion and extension from the sixth week on. Usually the caliper is worn for two hours once a day to stretch out the tissues. If they tend to contract the daily time for wearing the splint is increased.

51. Correction of Subluxation of the Tibia by Manipulation.—If the subluxation of the tibia is very slight it may be corrected by manipulation at the same time as the permanent knee flexion.

The patient is anæsthetized and turned over on his face. He is then drawn down so that the knee is at the edge of the table and a pillow

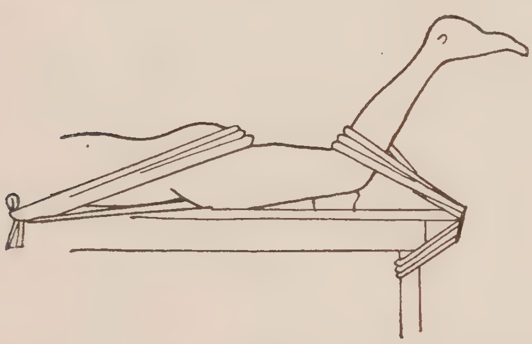

FIG. 74.—A method of correcting subluxation of the tibia by sheet traction; sheets applied first stage.

FIG. 75.—Method of using the lower leg as a lever to correct subluxation of the tibia, second stage.

is placed under the knee. An assistant holds the femur close to the knee and a second assistant holds his weight over the buttock. The operator flexes and extends the knee gently increasing the extension and forcing the tibia forward until the knee will slightly hyperextend. The patient is then turned over and a well padded and fitting plaster is applied as high as possible on the thigh and including the foot, holding the knee hyperextended.

The plaster is split on either side and may be loosened if the swelling is great. The patient should be kept quiet for three days and in bed for a week, after that he is up if the swelling and local symptoms have subsided. He is then allowed to walk with the plaster. When walking is easy a caliper splint is used during the day and a plaster at night.

As the knee becomes strong without tendency to recontract, the caliper splint is omitted more and more and used only two hours a day for one year. If the knee tends to flex, the caliper will have to be worn longer each day. The plaster at night is omitted after the surgeon has assured himself that the knee does not recontract during the day. When the flexion and subluxation are considerable a genuclast should be used to correct the deformity.

Manipulation of the Knee and Correction of Subluxation with Genuclast.—When there is subluxation of the tibia (see figure 73) the Goldthwait genuclast is used (see figure 72).

This apparatus is applied with the knee flexed preferably at right angles. The deformity will sometimes decide the position of the knee. One strap rests over the end of the femur, a second strap is placed over the front and lower third of the tibia and a padded plate is forced by a twin screw against the upper end of the tibia. By increasing the pressure on the upper end of the tibia, the subluxated tibia is brought forward; when this is accomplished the genuclast is reapplied as follows:

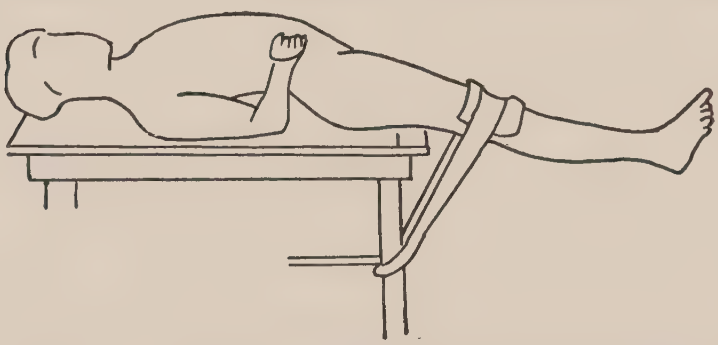

Fig. 76.—Method of maintaining hyperextension of the knee or other correction of deformities at the knee during the application of plaster.

The strap which did rest under the lower end of the femur is now placed on the lower end of the femur anteriorly; the padded plate and the strap remain the same. The pressure is now reapplied on the upper end of the tibia and the genuclast used to straighten the knee until it is slightly hyperextended. A plaster of Paris is then applied from the toes to the groin holding the knee slightly hyperextended. In straightening a knee in plaster any pressure with the hand should be above the patella, not over it; forcing the patella on the bone is undesirable. It should be remembered also that any pressure or denting of the plaster remains as a prominence pressing into the patient.

In correcting deformities at the knee it is important that sufficient correction should be done to obtain hyperextension of the knee easily maintained after the manipulation. This hyperextension should be so completely obtained that no force will be required in holding the knee in this position during the application of the plaster.

After the operation the patient is kept quiet for about three weeks depending on the amount of swelling. After that he is allowed to walk on the leg a little each day. At the end of six weeks, as soon as he walks well with the plaster on the knee, a caliper splint is applied (figure 475), which should be used at first night and day or during the day and replaced by a plaster at night. At the end of three months the caliper splint which hyperextends the knee easily is omitted for part of each day. When the knee shows no tendency to recontract, the apparatus is omitted at night at first and then omitted entirely, excepting for two hours each day. It should be used two hours each day at least one year. Recontracture often takes place very gradually and is not readily noticed. Any tendency to recurrence of the permanent flexion at the knee should be treated by longer or continued

application of the caliper splint. Exercise should be used to strengthen the leg and aid in locomotion.

In many cases where the permanent flexion at the knee has been prolonged, especially when subluxation is extreme and has existed for many years, there is a fibrinous union of the upper end of the tibia to the femur. Often this can be overcome only by an open operation. In these cases two incisions should be made parallel to each other, one, one inch to the outer side and the other one inch to the inner side of the patella about five inches long. The adhesions are relieved. They are often found most resistant on the posterior part of the femur. When they are relieved the straightening of the knee is carried out as indicated above. Care should be taken not to cut the lateral ligaments. If necessary they may be removed subperiosteally from their attachments to the femur or tibia but not cut across.

52. Another Method of Correcting Subluxation.—In certain cases when it is necessary to straighten a knee and a genuclast is not available, two folded sheets will sometimes answer in correcting the subluxation (see figures 74 and 75). The patient lies on his abdomen; a twisted sheet is placed between his legs and drawn up tight against the tuberosity of the ischium. The ends extend one toward the shoulder in front and the other behind. They are brought together at the head of the operating table and a webbing strap is passed through the loop and then fastened to the head of the operating table. This prevents the patient from sliding down off of the operating table when the leg is being pulled. A second sheet is applied around the upper end of the tibia which is slightly flexed and carried down to the foot of the table (see figure 74). This second sheet is made fast and held by the first assistant. The operator flexes the knee, which motion forces the upper end of the tibia downward. The operator then extends the knee. The first assistant takes in the slack in the sheet to accommodate itself to the extended knee and as the operator flexes the knee again, the tibia is thus forced further into place. This process is repeated and a great deal of force may be used until the subluxation of the tibia is overcome.

In cases where there is a partial ankylosis due to an old diseased process which has subsided, it is undesirable to use force in straightening the knee. It is also better not to do an arthroplasty. In these cases it is better to do an osteotomy through the femur, just above the adductor tubercle as described elsewhere in these pages. In some cases beside the flexion there is a knock knee or bow leg. Where the patient is young, it is possible to bend the leg at the epiphysis in the manipulation and to correct both the flexion and bowing at the same time. If this is undesirable an osteotomy is done and the correction made.

53. Operation for Knock Knee and Bow Leg.—For correction of knock knee and bowing at the knee, elaborate operations and removal of bone wedge are not frequently necessary.

Where the patient is an adult and the knock knee or bow leg is over

fifty degrees, a wedge of bone should be removed instead of doing an osteotomy. In other cases, excellent results are obtained by a simple osteotomy which is the operation of choice. This operation is not complicated and may be done rapidly. For bowing at the knee or knock knee, the operation on the bone is the same as that described for knee flexion. When there is bowing of the tibia and fibula a simple subcutaneous osteotomy of these bones with over-correction of the deformity is all that is usually required.

If, however, the bowing is anterior or very acute, a small wedge of bone must be removed; the bone heals without being fastened together. A tenotomy of the tendon Achilles should always be done when the deformity is in the lower leg. The after treatment is the same as for osteotomy at the knee.

54. Correction of Flexion Deformity of the Knee by Osteotomy of the Femur.—The patient lies on his back, the knee flexed at right angles; the operator stands on the side of the leg to be operated upon. A sand bag is placed under the knee, the adductor tubercle is felt through the skin. The osteotome is entered at the inner side of the leg just over the tubercle until it reaches the tubercle with the blade parallel to the femur. The operator prevents the slipping of the skin under the osteotome by placing the thumb and forefinger of the left hand on either side of the adductor tubercle, the thumb anterior, the index finger posterior. In stretching the skin with these fingers which are kept only a quarter of an inch apart, it is very easy for the osteotome to incise the tense skin without slipping. As soon as the periosteum can be felt by the cutting edge of the osteotome, the operator turns the cutting edge at right angles to the bone so that it will lie across the femur. The osteotomy should be done in the flat portion of the femur and not in the round position (figures 494 to 496).

55. Technique of Osteotomy of the Femur for Flexion Deformity of the Knee.—The knee should be flexed at right angles for the operation in order to avoid the vessels and nerve close to the bone. The operator in using an osteotome should learn to cut and then to feel and then to cut what he feels with the osteotome, rapidly. In this way the osteotome is used as a probe, and as a cutting instrument. Some operators prefer to cut the anterior edge of the femur and then to place the osteotome back of this and cut another layer repeating the process layer by layer, progressing toward the back of the bone. The osteotome in cutting inclines forward and cuts the bone as marked in figures 52, 53. The osteotome inclines forward again and cuts next as shown in figure 54. Cutting the bone close to the adductor tubercle prevents the antero-posterior deformity so often seen above the knee, when the osteotomy is done too high. The bone is in a better line than when the osteotomy is done low down. See figure 494.

No suture is necessary in the small hole made by the osteotome. The knee is now straightened and the deformity corrected. If it is a bowing

at the knee, the leg should be put up in very slight knock knee. If the osteotomy is done for a knock knee, it should be put up in a very slight bow leg position. In all osteotomies, as soon as the bone is cut through, the leg should be held very carefully by an assistant and no jar allowed. Manipulation of the knee should not be done when an osteotomy is contemplated as it will add to the trauma and the motion which exists is apt to be lost in consequence. Sterile sheet wadding is placed around the leg at the region of the osteotomy and the whole leg covered with sheet wadding from the toes to the groin. A well fitting plaster is applied immediately and held in position until hard.

56. The Application of a Plaster of Paris Bandage After Operation or Manipulation of the Knee.—To facilitate the correction of knock knee or bow leg and at the same time to obtain a slight hyperextension of the knee during the application of plaster, the following method is of service in very muscular individuals or when much force is necessary. The leg having been covered with sheet wadding from the toes to the groin, a heavy felt pad is placed just above the knee, a double four inch bandage is spread over this pad and its four ends carried down to a leg or cross bar on the operating table and tied there (see figure 76). The operator can then slightly hyperextend the knee and correct the bowing or the knock knee during the application of the plaster (figures 77, 78). When the plaster has hardened the bandage is cut away from its attachment. In cases where correction of knee deformity has been done the plaster should extend high on the thigh. It should grasp both ends of each bone and fit the thigh well and fit the leg and foot well. Only in this way can the full correction be maintained.

57. Plaster for Holding the Knee.—The plaster should fit holding the upper and lower part of the femur and the upper and lower part of the tibia. The over-correction is maintained.

In correcting bowing at the knee and knock knee, the plaster should be applied with the knee slightly hyperextended. The plaster is applied from the toes to the groin and split on either side.

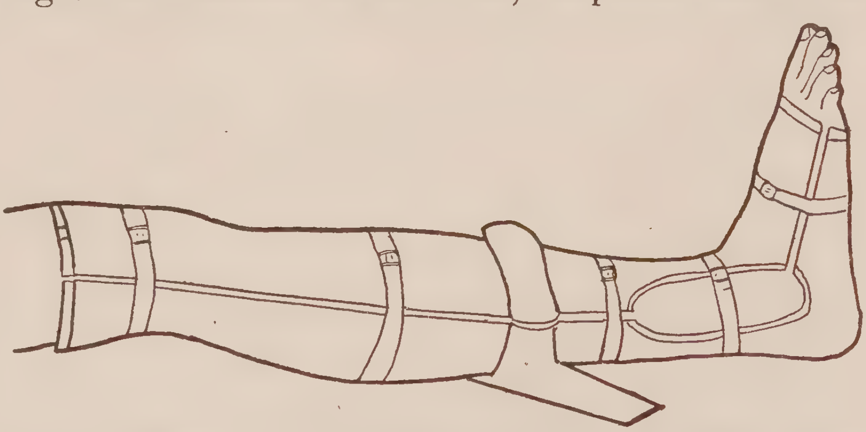

Fig. 77.—Plaster rope to prevent rotation of the plaster after fracture or operation on the leg. Lateral view.

58. After Treatment and a Simple Method of Preventing Rotation of a Leg Plaster.—Plaster ropes are applied to prevent the rotation of the leg as shown in figures 77, 78. The patient should be disturbed as little as possible for the first five days, excepting for the use of the bed pan. He may be allowed to have a bed rest in two

weeks and to sit up after the third week, depending on the case. Some cases are better in bed for five or six weeks. The leg should be kept quiet for about five weeks when the patient is allowed to get up and move around with crutches. At the end of the sixth week he is encouraged to bear weight on the leg. As soon as the patient can walk with the plaster easily it is removed for a part of each day

FIG. 78.—Plaster rope to prevent rotation of the plaster after operation. End view.

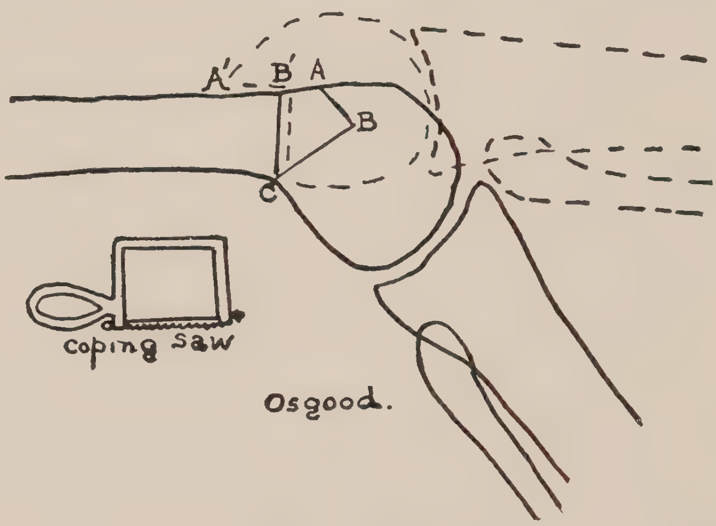

FIG. 79.—Dr. Osgood's method of correcting knee flexion, removal of bone, A B, C, B′ with coping saw.

and discarded as soon as possible, depending on the strength of the leg.

When no operation has been done on the bone, as soon as the reaction following the manipulation has subsided, the patient is allowed to sit up and then to walk.

59. Dr. Osgood's Method of Removing Bone for Flexion Deformity at the Knee.—Dr. Osgood has suggested a method of removing a wedge from the femur by means of a coping saw applied to the femur through two lateral incisions. A tracing of the x-ray before operation will help the operator to decide on the size and shape of the wedge to be removed (see figure 79 A, B, C, B′). A quadrilateral piece of bone is sawed out allowing correction of the knee flexion (see figure 79 A′, B′, C). The cut A–B is made three-fourths of an inch long, then B–C not through the posterior shell of bone. The saw blade is left at C. Another blade is inserted at B′ and cuts toward C. The bone wedge is slid out and the posterior shell at C broken or bent as the leg is straightened. The after treatment is the same as for osteotomy above described.

CHAPTER II

MUSCLE AND TENDON OPERATIONS—MUSCLE AND TENDON TRANSPLANTATION

60. Operation for Rupture of the Quadriceps Extensor.—For rupture of the quadriceps a long median incision is made. The upper and lower ends of the muscle and its sheath are sutured with quilted silk sutures (see figure 218). The silk is pulled together approximating the edges of the lower muscle; interrupted chromic catgut sutures number 00 are used for the edges of the muscle, the silk being used to relieve the tension. It is important to suture the muscle sheath with interrupted catgut sutures number 00. The fat is brought together with interrupted chromic catgut, the skin with continuous chromic catgut number 00. Large protected wads of sheet wadding are placed over the muscle in addition to the circular layers. The leg is put up in plaster of Paris with the knee fully extended. The patient is placed in bed with a low bed rest and the leg elevated. Quiet in bed is necessary for about four weeks; a little more freedom may be allowed in the next two weeks. The plaster is removed after the sixth week. In patients over thirty, slight passive motions of the knee should be allowed daily after the third week in plaster.

Fig. 80.—Tendon carrier.

61. Operation for Muscle Transplantation, Paralysis of the Anterior Thigh Muscles.—When a vigorous muscle is transplanted strong muscular action can usually be expected. In the choice of muscles to be transferred from the back of the leg forward, the sartorius and the inner hamstrings are preferable to the biceps. The biceps, however, may be transplanted at the same time with one of the others.

Fig. 81.—Sartorius incision anterior; hamstring incision posterior.

Before transplanting, any slight degree of flexion or knock knee is corrected by manipulation. When extreme knock knee or extreme flexion is present this should be corrected at a previous operation. At the time of operation the knee should hyperextend slightly without the use of force. When this is accomplished the transplantation may be done.

OPERATION

A rubber bandage is applied from the toes to the groin, a tourniquet is applied high in the groin with the loose ends turned upward to allow the skin to be prepared very high. The patient is prepared with scrupulous care as to aseptic detail, the hip is flexed and abducted,

FIG. 82. — Exposure of muscles.

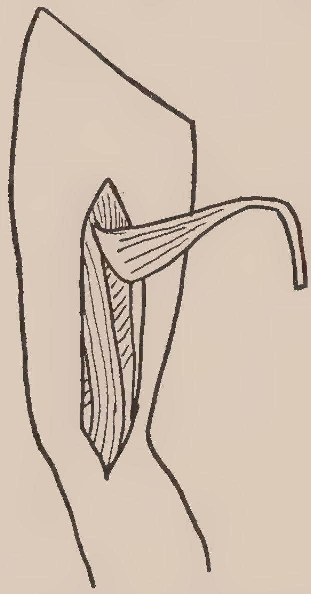

FIG. 83.—Muscle dissected up.

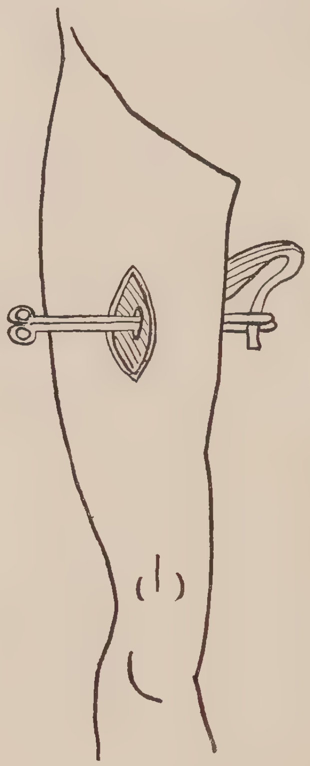

FIG. 84. — Tendon carrier, reaching posteriorly for the hamstring tendon. The line over the patella shows the incision here, and over the tibia the second incision for insertion of the silk tendon elongation.

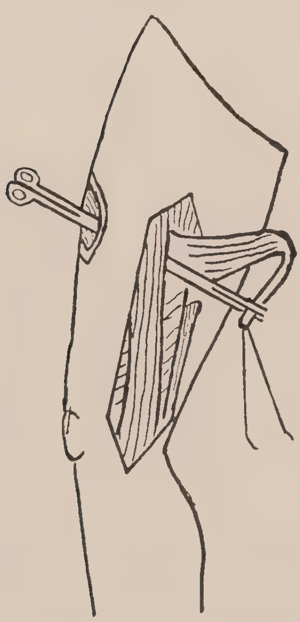

FIG. 85. — Lateral view of the tendon carrier reaching for the hamstring tendon.

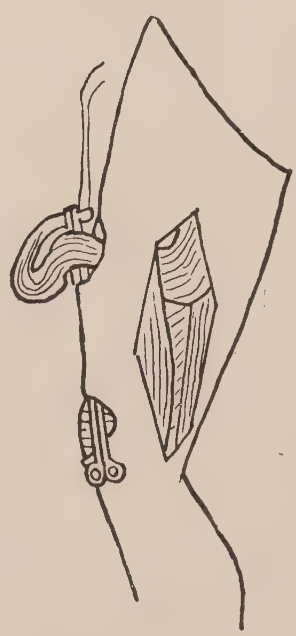

FIG. 86. — Tendon carrier passed upward through the subcutaneous tunnel.

slightly; an incision is made starting one inch above and half an inch posterior to the internal condyle, the incision should be carried vertically through the skin and subcutaneous fat parallel to the femur and extend upward to the middle and upper thirds of the thigh. The muscles are examined to determine their relative strength. For practical purposes a totally paralyzed muscle will be gray, or grayish pink. A partially paralyzed muscle is pink, a strong muscle is red.

At the lower portion of the wound the belly of the semi-membranosis

is seen, then the tendon of the semi-membranosis and finally the tendon and muscle of the semi-tendonosis overlying the semi-membranosis. The semi-tendonosis and the gracilis have long thin tendons, and are chosen for transplantation rather than the semi-membranosis.

When there is a paralysis involving the muscular action of the knee joint, it is undesirable to carry the dissection down below the condyle, for elaborate dissection at the side of the joint weakens it laterally. For this reason the skin is drawn downward and the tendon cut away as low as possible without being traced to its insertion beyond the joint line.

The transplanted muscle (see figure 97) may be passed through a slit in the quadriceps tendon or muscle before being attached to the quadriceps tendon and patella as described above.

For the success of the operation further details are necessary. The surgeon should see that the portion of the silk hooked through the eye of the carrier is cut off later in order not to mutilate the silk that is to remain in the leg, either by bending or clamping it. Any injury to the silk which is to be left in the patient is undesirable. The surgeon should carefully test the silk and endeavor to break it with his hands at several points before quilting it through the tendon. The stitches in the tendon should be placed carefully and close together and not in the same line of cleavage. They should number about seven or eight on each side of the tendon.

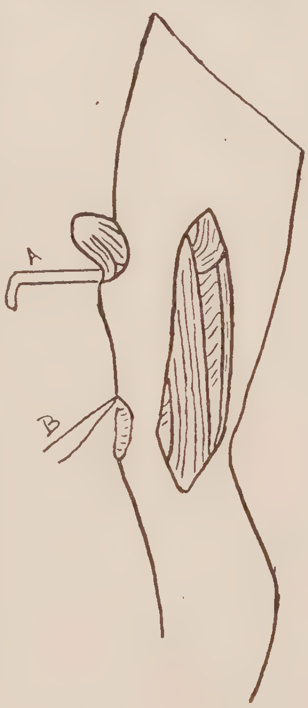

Fig. 87.—A, Retractor preventing the infolding of the fat while the muscle is drawn downward subcutaneously to the patella. B, Silk extending to the tendon of the hamstring in the tunnel.


Fig. 88.—Position of insertion of an internal hamstring first into the patella, second to the outer tibia.

When there is little or no tendon, as in the case of the sartorius, "larger bites" through the muscle are necessary in order not to cut off the circulation of the muscle. In figures 93 and 95 the tendon protrudes through the lower incision and is quilted into the patella. The silk is tied here; another incision is made over the outer side of the upper end of the tibia one-half inch internal to the upper end of the fibula, curved and two inches long. The silk is quilted here into the periosteum and tied as shown in figures 91 and 92.

At the thigh in transplanting a posterior muscle forward, the transplanted muscle may be attached directly to the quadriceps tendon and to the patella by the silk extension from the tendon (see figure 93). When the sartorius is transplanted it is attached to the quadriceps and then the silk is carried over the patella down directly in a straight line and inserted in the upper end of the tibia. The muscles are transplanted in the middle line above the patella. Below the patella the silk from an inner hamstring is carried to the outer side of the tibia; that from an outer hamstring is carried to the inner side of the tibia. The knots tied three times in the silk are cut, leaving ends just long enough so that they will bend over and not stand up. They are also pressed firmly into the periosteum after being tied in order that they will lie as flat as possible. The muscle is dissected up to the middle of the thigh. A longitudinal incision is next made on the anterior and middle third of the thigh parallel to the femur down to the quadriceps muscle. The incision is retracted, a blunt dissector is used to make a tunnel backward connecting the anterior with the upper end of the posterior incisions. A long clamp or tendon carrier (see figure 80) is inserted into the tunnel (see figures 84, 86), anteriorly; it grasps the tendon of the semi-tendonosis and draws it forward out through the anterior incision (see figures 87, 88). In the case of the transplantation of the sartorius or of the gracilis, this tunnel should extend immediately under the fat and not through the paralyzed muscle there. A towel is placed on either side of the muscle while the heavy number eighteen braided silk is quilted up one side of the tendon and down the other (see figure 89).

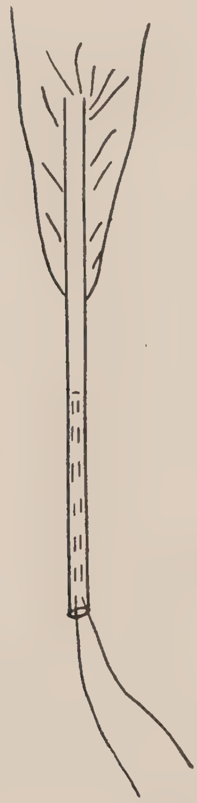

Fig. 89.—Method of quilting silk into a tendon.

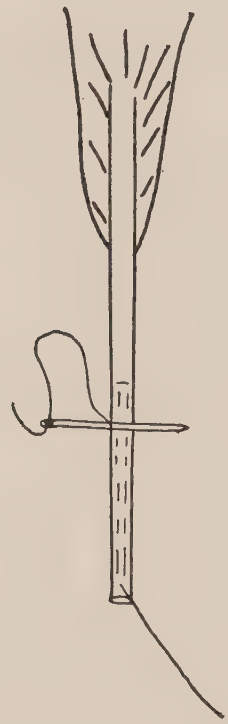

Fig. 90.—The needle must enter the tendon at right angles.

The method of inserting silk is extremely important. The tendon fibers are easily split and tear readily. Each puncture of the needle should be made at right angles to the fibers of the tendon as shown in figure 90.

Another incision is made parallel to the femur starting one inch below the upper edge of the patella, extending upward two and one-half inches directly over the centre of the patella. The incision is carried down

through the superficial fascia and fat. A tendon carrier (see figure 80), is inserted at the patella incision making a broad tunnel in or below the subcutaneous fat connecting the two anterior incisions. The tendon carrier is passed upward in the tunnel to the upper thigh incision. The silk is passed through the eye of the carrier and pulled through the tunnel followed by the tendon and muscle. An assistant raises the lower end of the wound as shown in figure 88 to prevent inversion of the fat at this point while dragging the muscle through the tunnel. The transplanted muscle is attached by mattrass sutures to the quadriceps tendon. Both muscles are scarified before placing the sutures. The muscle is also attached to the quadriceps muscle and tendon just above the patella. This is done with interrupted silk sutures. The quadriceps may be folded over the transplanted muscle or slit to receive it before applying the interrupted silk sutures.

The silk ends from the transplanted tendon are threaded through periosteal needles (see figure 281) and inserted by quilted sutures into the patella (see figures 91 and 92). The silk is tied here and then passes subcutaneously to the tibia. A small curved incision is made here and the silk quilted into the periosteum over the tibia. The deep tissues are brought together with interrupted chromic catgut sutures number 00 carefully covering the silk and the knot. The subcutaneous fat is brought together over this with interrupted chromic catgut sutures number 00, the skin with continuous chromic catgut sutures. About five or six layers of gauze one and one-half inches wide are laid over each incision extending one-half inches beyond at either end of the incision. Over this is placed sterile sheet wadding. See figures 234 to 236. See method of applying dressing under transplantation of peroneus forward, section number 147.

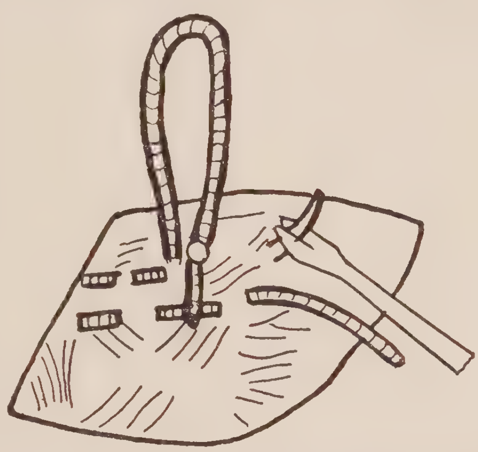

Fig. 91.—Needle and insertion of silk into the periosteum.

Fig. 92.—Quilted silk suture inserted in the periosteum and tied.

Fig. 93.—Insertion of silk into patella and into tibia.

62. Transplantation of Two Hamstrings Forward.—When an outer as well as an inner hamstring is transplanted forward the process is the same. The two muscles are brought out of the anterior incision, one passes to it on the outer side of the leg, the other on the inner side. They

are both passed down the same tunnel to the patella and fastened to the quadriceps muscle or its tendon, both by mattrass sutures and then stitched to the patella. The silk from the inner muscle is cut from the start one inch or one and one-half inches shorter than the silk from the

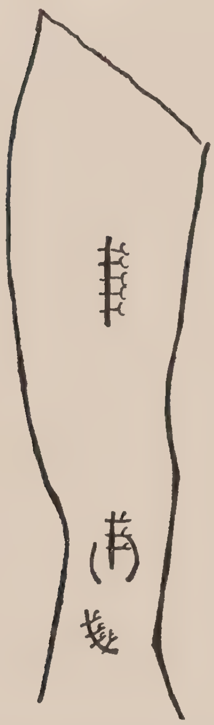

Fig. 94.—Closing anterior incisions.

Fig. 95.—Diagrammatic representation of the transplantation of two hamstrings forward for paralysis of the quadriceps.

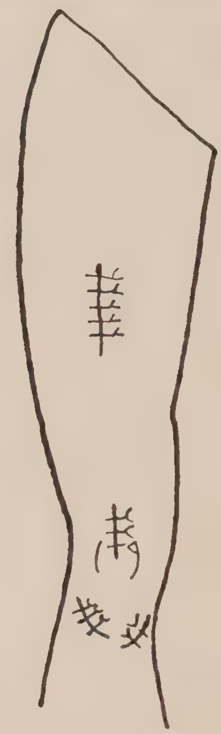

Fig. 96.—Anterior incisions closed after transplanting two hamstrings to the patella and tibia for paralysis of the quadriceps.

outer muscles. In this way it may be distinguished after being quilted into the patella and tied. The quilting in the patella is made separately (see figure 95), for each strand. After insertion into the patella, the four strands are tied together after being tied in pairs. They are next inserted into the periosteum over the tibia, the two strands of silk from the outer hamstring to the inner side of the tibia, and the two strands of silk from the inner hamstring are carried to the outer side of the tibia. The strands are distinguished by their length as noted above. The knots are flattened and pressed firmly into the periosteum. The silk and knots are carefully covered with deep tissues, the subcutaneous tissues are brought together over this with interrupted chromic catgut sutures number 00, the skin with continuous chromic catgut sutures number 00. When the incisions are closed they appear as shown in figure 96.

63. Operation for Transplantation of the Sartorius Muscle for a Weak or Paralyzed Quadriceps.—In a transplantation of the sartorius, this muscle when transplanted will easily reach the patella. It is usually sutured to the quadriceps tendon, the two muscles scarified first. Silk is quilted into the muscle as described for transplantation of the semi-tendinosus or the peroneus. The silk is carried down and in-

serted into the patella and then into the tibia in the median line, otherwise the operation is the same as in transplantation of the semi-tendinosus forward. The sartorius is an easy muscle to transplant and when strong is always successful in its new position.

64. Transplantation of the Tensor Fascia Femoris, to a Weak or Paralyzed Quadriceps.—The patient lies on his back, the operator stands on the side of the leg to be operated upon.

An incision is made to the patella starting two inches below the anterior superior spine. The tensor fascia femoris muscle is exposed and a broad strip of fascia traced down to two inches above the patella. This is cut away below, dissected up, quilted up one side and down the other with silk, the fascia and muscle transferred inward entering a slit in the quadriceps tendon and being attached by quilted sutures to the quadriceps tendon and patella. The rest of the operation and after treatment differ in no way from that used in the transplantation of the semi-tendinosus. See section 61.

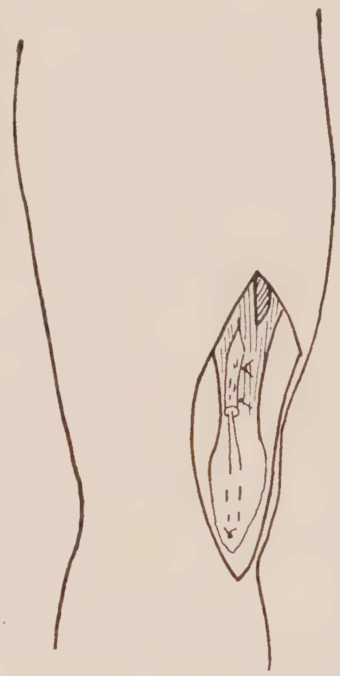

Fig. 97.—Passing the transplanted muscle through the quadriceps and then attaching the silk extension to the patella and tibia.

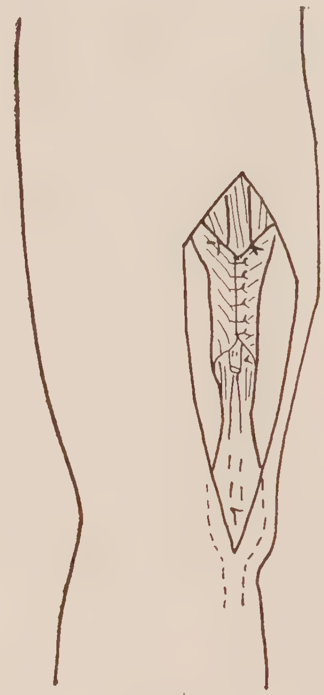

Fig. 98.—The paralyzed quadriceps is folded in part over the transplanted muscle which is attached to the patella and again to the tibia.

65. Transplantation of the External Hamstrings Forward, for a Weak or Paralyzed Quadriceps.—In transplanting the external hamstring, the biceps femorus, the short and long heads come together into one tendon. The incision for transplanting this tendon should be one or two inches from the median line. In transplanting this muscle forward it is better that the tunnel should pass through to the inner side of the vastus externus, for it is difficult to make the muscle reach. The tendon should be cut very low for the same reason. The procedure otherwise is the same as for transplantation of the inner hamstring.

66. Technique of Muscle Transplantation.—In transplanting muscles or tendons from their position to take up the work of other muscles, it is important to weigh the strength of the paralyzed group, and determine the strength of the muscles to be transplanted and the strength of the joint after removing this good muscle. If the joint stability is in any great degree affected by the transfer, this must in some way be

compensated for and if it cannot be, the operator should consider the value of the transplantation with these facts in mind.

At the time of operation, a red muscle will be a good one to transfer, a pink muscle may be of help in its new position but if it is a pinkish gray or fatty it will be useless when transplanted. The muscle to be transferred should be dissected up for at least one-half of its length from its insertion, carried forward or backward as the case may be, and then placed in a tunnel in a direct line for the desired new pull. The silk quilted into the tendon should extend some distance up the tendon in order not to be easily pulled out. The silk should be heavy number sixteen or number eighteen, braided. It should be tested to see if it will break before inserting it in the tendon. The silk can be made to reach any distance. In the process of repair it is covered completely by fibrous tissue which will strengthen it. The insertion of the silk into the periosteum should be three or four quilted sutures for each strand (see figure 91, 92), and then the ends are pulled tight one at a time, taking up the slack in the muscle and then tied three times, the end cut so that it will bend over. The knot is pressed into the underlying tissue using the handle of a pair of dressing forceps. The operator should assure himself that the transplanted muscle is pulled well down into its new position and is not caught by any constriction in the canal in which it has been placed. The insertion of the silk should be under a curved flap, the base of which overlies the knot. The silk should be covered by deep fascia or muscle when possible beside the skin and fat. No pressure should be allowed over the transplanted muscles or the incision. The dressings or plasters should be well padded for this purpose.

67. Muscle Transplantation for Paralysis of the Anterior Thigh Muscles.—One or more posterior thigh muscles may be transplanted forward to re-enforce a very weak quadriceps or to replace a paralyzed one. It must be borne in mind that the object of the transplantation is primarily to give stability to the knee. A very weak or paralyzed quadriceps is a constant menace to the patient. In walking he cannot lock the knee and be sure when transferring the weight from the good leg to the affected leg that it may not give way under him. In walking he instinctively places the hand on the thigh to prevent the flexion of the knee as the weight is being transferred to that leg.

Fig. 99.—Roll of sheet wadding applied after tendon transplantation before applying the plaster.

Stability in standing, the motions of stepping up and of stepping

forward, as well as the extension of the knee are largely dependent on the quadriceps. When this muscle is absent, or deficient, one or more of the posterior thigh muscles may be transferred forward. While in transplantation none but good strong muscles should be used as a rule, in the case of the knee a weak muscle, when there are no others, will help give stability when transplanted even if it is not strong enough to extend the knee with force. When such a transplantation is performed the patient or his relatives should realize the purpose of the operation in order not to expect more than the increased stability of the knee where such a weak muscle is used.

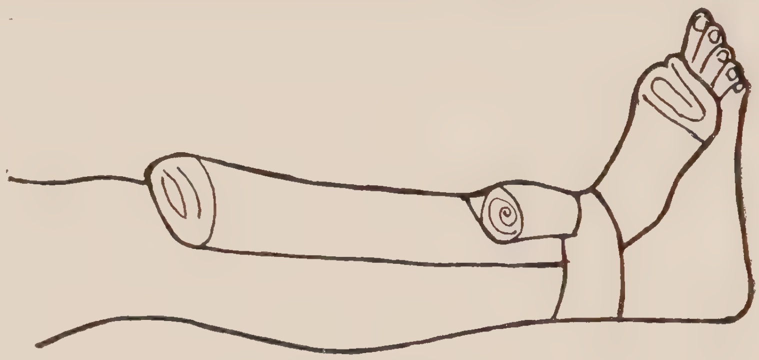

FIG. 100.—Sheet wadding being applied over roll of sheet wadding.

68. Plaster of Paris Bandage Following Transplantation in the Thigh.—A plaster of Paris bandage is applied from the toes to the groin and split on either side when dry enough. The knee is held slightly hyperextended. No pressure should be allowed on the knee cap or on the transplanted muscles. To avoid this a great deal of folded sheet wadding is laid over the anterior part of the thigh and patella before applying the circular sheet wadding (see figures 99, 100, 101). The foot of the plaster should be elevated and always loosened but strapped at either side. While there is usually much swelling there will be comparatively less if the operator avoids roughness in handling the tissues.

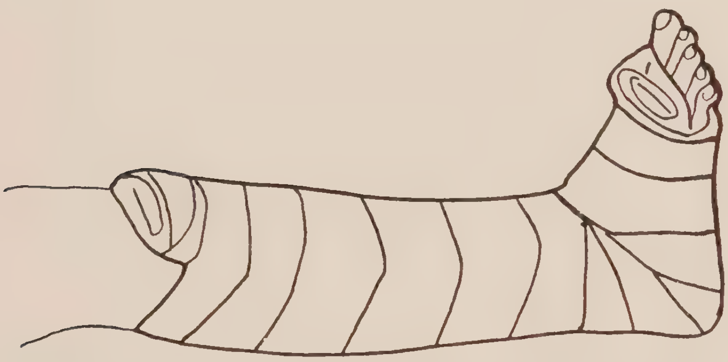

FIG. 101.—Sheet wadding rollers applied for plaster. After a tendon or muscle transplantation the plaster should extend as high as possible on the leg and include the foot.

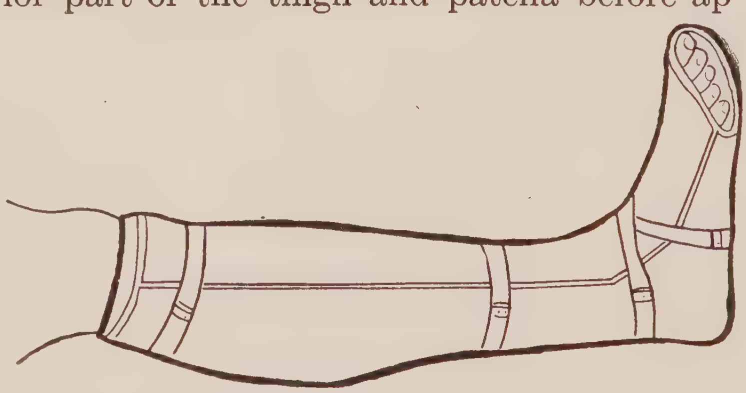

FIG. 102.—A plaster whether extending to the groin or the knee may be split at the sides so that it can be loosened or taken off.

After Treatment

The patient is kept on his back for a week and then raised forty-five degrees on a bed rest for part of the time. When the swelling has sub-

sided he may sit up in bed. He should not move much for two weeks; after that he may change his position frequently in bed. At the end of six weeks he is allowed to get out of bed in a chair or go-cart. At the end of eight weeks the plaster is changed and the patient walks with crutches on the other leg, gradually using the leg operated on. A caliper splint is used after the tenth week, replaced by the plaster at night. Muscle training and exercises are kept up for a year and a half at least. The knee is allowed to bend fifteen degrees at first but not more than forty-five degrees for a year; after that flexion is allowed just short of a right angle. Early stretching beyond a right angle weakens the muscle.

69. Myotomy of the Adductors and Hamstring Muscles. For Contracted Muscles.—When the adductor muscles and hamstrings are contracted and will not yield easily to gradual or forcible stretching under anæsthesia, they are better lengthened in the tendinous portion as described under tendon lengthening. The contraction may be due to disease, to injuries or to habit of position or abnormal tensions, and in spastic paralysis it is often necessary to throw the contracted spastic muscle temporarily out of commission. In this class of spastic cases a simple myotomy may be done. If it is necessary to put the muscle absolutely out of commission, in order that locomotion may be possible, either a transplantation of the muscle is made to where it will be more useful or a section from the muscle is removed.

70. Operation for Tenotomy of the Hamstrings or Tendon Lengthening.—This operation should never be done subcutaneously. A very small incision should be made over the outer and another over the inner side of the popliteal space. Each tendon is lifted out on a blunt dissector or grooved director and tenotomized, care being taken not to cut the nerves which are large. The surgeon may feel for each tendon, lift it and cut it in turn. The actual cutting of the tendon should be according to the rules laid down elsewhere in these pages under tenotomy and tendon lengthening (see section 127).

The after treatment is the same as that laid down for myotomy of the hamstrings. See section 82.

Sometimes a hasty operation is all that the patient will stand if he is weak or is bedridden. In this type of case the legs should be made straight and the muscles stretched enough at each joint simply to make standing and locomotion possible. The foot should never be forgotten. A good hip or patched up knee is not very useful if the foot cannot be used for standing. In a few cases one leg must be done at a time.

In cases for myotomy when the patient is not strong enough to have one leg made good for weight bearing it is better to wait and strengthen the general condition by rest, exercise, hygiene, etc.

71. Myotomy in Spastic Paralysis.—A myotomy of the adductor or inner and outer hamstrings or of the peronei or the muscles of the leg or arm is performed in a similar way to that described under myotomy for the inner hamstrings. The surgeon should remember that tenotomy

or tendon lengthening when applicable is preferable to myotomy excepting in spastic paralysis and other paralysis when it is necessary to throw out of action muscles that are a hindrance to locomotion.

Spastic cases not able to walk on account of the adduction of the thigh and flexion of the knee are greatly relieved by this operation. They may walk at first with difficulty and with apparatus only, but later will improve a great deal.

72. Operation for Myotomy of the Internal Hamstring.—A vertical incision four inches long is made on the inner and posterior aspect of the thigh at the junction of the middle and lower third down to the muscle layer. The semi-tendinosis is posterior and may be recognized by its long tendon, the semi-membranosis by its large bulk and low muscle fibers, the gracilis is forward of this with a long tendinous portion and the sartorius is a flat muscle, narrow and long with parallel edges; it has almost no tendon. The muscles selected for myotomy are taken in turn, the fibers are lifted on a director and cut a few at a time. This is repeated until the muscle is completely cut across. If the muscle is to be completely thrown out of commission, as in certain cross legged spastic conditions, a section one or two inches is cut out of each muscle as follows.

73. Operation for Removing a Section from a Muscle.—In removing a section the muscle is cut twice. For the upper cut the muscle fibers are lifted on a director a few at a time as described above for a simple myotomy. A second cut is made one or two inches below. The lower cut is made at once with scissors. When the muscle is very vascular it is transfixed in one or two places with a stab needle, double ligatures passed through interlocked, and tied as in tying pedicles. The muscle is then cut. A second cut is made one and one-half inches lower, the muscle tied off in the same way. The tying of a muscle before cutting is rarely necessary. The ends thus separated and tied are not apt to reunite. The subcutaneous fat is sutured with interrupted chromic catgut sutures number 00, the skin with continuous chromic catgut sutures number 00. No hemorrhage is likely even when large vascular muscles are cut across. The operator may prefer to turn back and suture the ends of the muscle myotomized. This will effectually prevent reunion.

At the time of operating on the muscles, the joints should be limbered up allowing normal motion at the hip; the knees hyperextended slightly and flexed to a right angle. The ankle motion should also be investigated and made suitable for weight bearing and walking. In other words, the deformities and limitations of motion should be overcome.

After Treatment

The joint about which the myotomy is done should be immobilized by a plaster of Paris with the muscle held stretched out for eight weeks. When the plasters are removed, caliper splints should be used to keep the

knees slightly hyperextended. The length of time necessary for the caliper splints depends on the tendency of the knee to contract. The splints are omitted a little and the time increased accordingly until they are worn each day one or two hours only. This is kept up for a year. The abduction is maintained part of each day by a wooden spreader between the braces. Any tendency to recontraction is followed by more vigorous use of the splints. The legs should be watched so that motion in abduction is easy and hyperextension of the knees possible without using force.

74. Operation for Tenotomy of the Adductor Magnus.—This tendon is easily felt just above the internal condyle of the femur. An incision is made one-half inch or one inch long just enough for the finger to feel the tendon (see figure 48), it is hooked up on a blunt dissector and tenotomized; one suture closes this incision. This operation is especially useful for contractures of the unopposed adductor; it is also useful in helping relax a difficult and shortened dislocated femur, or before performing an arthrodesis at the hip or to help overcome adduction for any reason.

CHAPTER III

OPERATION IN CASES OF PARTIAL AND TOTAL PARALYSIS

75. Arthrodesis at the Knee in Paralytic Conditions (See also Chapter II).—In infantile paralysis and other paralytic conditions elaborate operations and heavy apparatus are to be avoided whenever possible. When there is a complete paralysis of the muscles about both knee joints, especially when the hip muscles are good, it is often desirable to relieve the strain of carrying apparatus by stiffening one knee.

The usual semilunar incision is to be avoided as should most of the cross incisions in paralytic conditions. The circulation and repair is naturally poor. In order to interfere as little as possible with the circulation, longitudinal incisions can be made on either side of the patella four or five inches long in order to allow easy retraction of the tissues. Very much less disturbance of the circulation is obtained by this method than by the usual semilunar incision. A bayonet incision is often preferred in these cases.

OPERATION

A rubber bandage is applied from the toes to the groin and a tourniquet is applied here, the leg having been carefully prepared. Any deformity, such as flexion or bow leg or knock knee should be corrected. A bayonet incision or two parallel incisions are made four inches long, one, one inch from the outer border, and the other, one inch from the inner border of the patella (see figures 119 and 120). They should extend from the cross incision over the patella upward and downward two inches. The incisions are carried down to the bone, the soft tissues retracted exposing the knee joint (see section 92). The lateral ligaments are incised or detached subperiosteally and an osteotome is used to remove the articular surface of the tibia or a saw when a large slice of bone is to be removed. The lower end of the femur is also shaved off with an osteotome, the two bony surfaces brought into firm apposition and sutured laterally and anteriorly by means of heavy silk or silver wire. Bone plates may be used, vanadium steel plates are easily bent and the surface of the bone should be cut with an osteotome to receive them so that their surface will lie flat. The under side of the patella may be cut away with an osteotome and mortised into a groove cut in the anterior surface of the tibia and femur, the patella being pulled down and firmly anchored to those bones by means of silk (see figures 103, 104, 105). This latter procedure is unnecessary

when a bony arthrodesis has been done. It may be used as a substitute for the bone operation. A bone graft from the tibia will help lock the bones together. The graft is taken from the same leg, as recommended by Albee. In cases other than infantile paralysis an arthrodesis is done

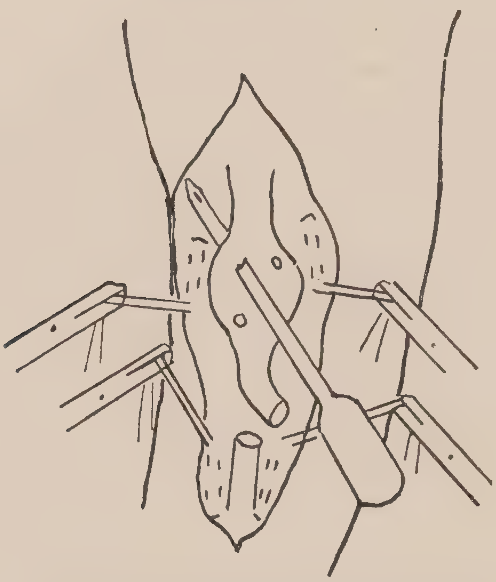

FIG. 103.—After excision or arthrodesis, silk ligaments applied to the patella, step I.

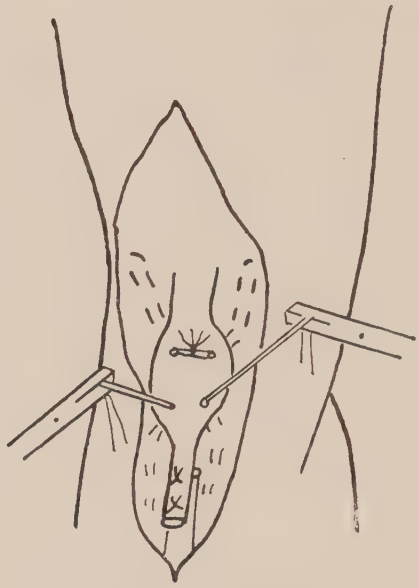

FIG. 104.—After excision for arthrodesis, silk ligaments applied to the patella, suture of patella tendon, step II.

like an excision through an anterior semilunar incision. See elsewhere in these pages, excision of the knee. See section 97.

76. Operation for Flail Condition of the Knee.—When there is a paralysis of the muscles of the leg in extensive paralytic conditions not only is the knee flail because of the lack of power in the flexors and extensors but the ligaments lack tone and are stretched out so that there is a lateral flail condition as well as an antero-posterior. For the slight conditions, the Barlow silk ligaments are sufficient. For the very extreme cases an arthrodesis at the knee and a bone graft in addition is indicated. This eliminates elaborate apparatus and allows the use of the leg without cumbersome braces. When the hip muscles are good the result is especially gratifying. Locomotion becomes easy, the weight of apparatus is eliminated and the circulation in the leg becomes greatly improved.

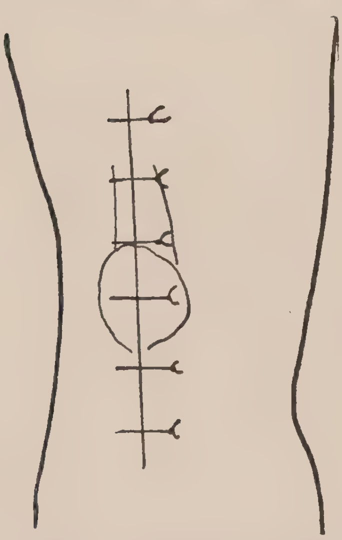

FIG. 105.—After excision for arthrodesis, silk ligaments applied to the patella, wound closed, step III.

FIG. 106.—View of popliteal space incisions for silk ligaments.

77. Operation for Inserting Bartow Silk Ligaments at the Knee in Paralytic Conditions.—The Bartow method of inserting silk ligament has proved of service especially at the knee and shoulder. The ligaments are introduced intra-articularly going through the bone below, the joint and the bone above, then down in front of the bone, preferably through the capsule of the joint and in front of the bone below and tied. They may be inserted subcutaneously without incision, at the shoulder and at the front of the knee. At the back of the knee, however, it is better to make a small incision (see figures 108, 109 and 110) for the entrance and exit of the special curved drill. This instrument consists of a handle (see figure 109), and a set of drills which are long and have different curves, the operator selecting the curve most adapted to the joint which he is operating upon.

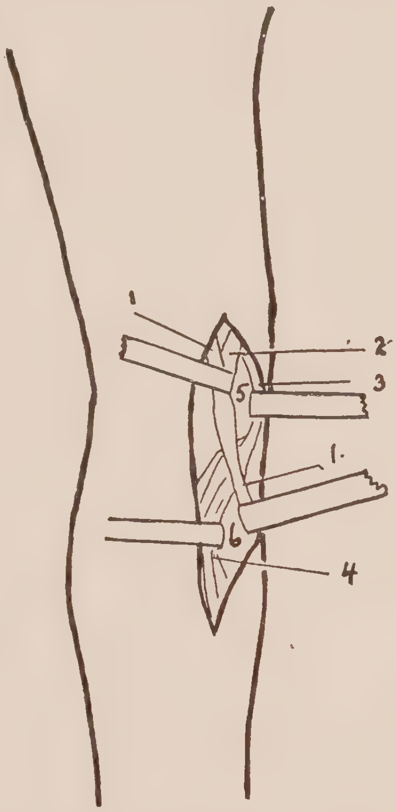

Fig. 107.—View of popliteal space, insertion of a posterior inner silk ligament. 1. Semi-tendonosis. 2. Semimembranosis. 3. Gracilis. 4. Inner head of gastrocnemius. 5. Femur. 6. Tibia.

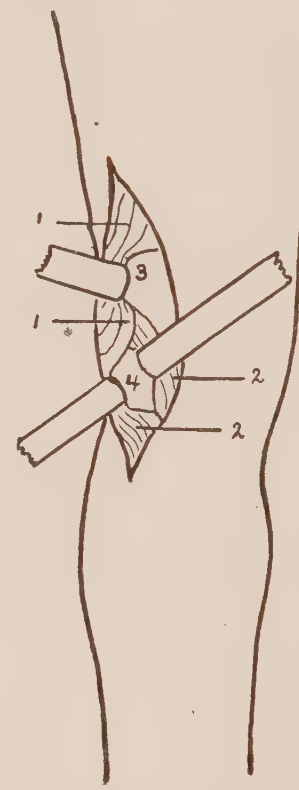

Fig. 108.—View of popliteal space, insertion of a posterior external silk ligament. 1. Biceps. 2. Gastrocnemius. 3. Femur. 4. Tibia.

When there is no power of extension of the knee or when this power is

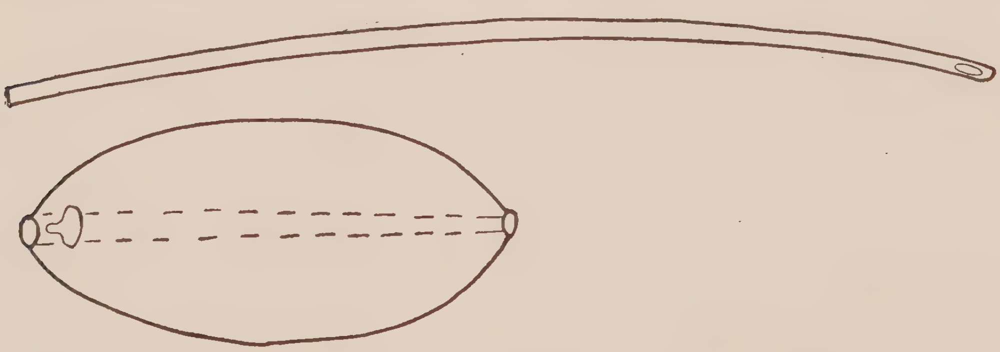

Fig. 109.—Bartow drill. The handle allows the drill to protrude slightly as it enters the bone. The drill handle slides back on the drill and is held by a thumb screw. The drills are made with different curves all fitting into the drill handle.

so slight that it is impossible for the patient to use the knee satisfactorily without a splint, the Bartow silk ligament may be used instead of a brace.

They will hold the knee firmly, sometimes allowing a little motion but not enough to give way when weight is applied to the leg. When there is a flail condition of the knee four or six ligaments may be applied, two anteriorly and two posteriorly. When the knee tends to hyperextend backward and there are muscles anteriorly, two posterior ligaments may be used. They will, however, limit the motion of the knee somewhat. Where the muscles are weak this limitation is not undesirable. In selected cases the Bartow silk ligaments are most useful at the knee.

OPERATION

The leg having been cleaned, prepared and protected as for any joint operation, a Bartow drill (see figure 109), is entered one inch or one and

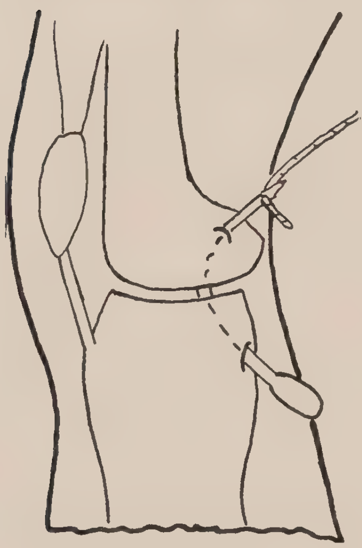

Fig. 110.—Bartow silk ligament at the knee, insertion of the drill. The eye of the drill is threaded with silk.

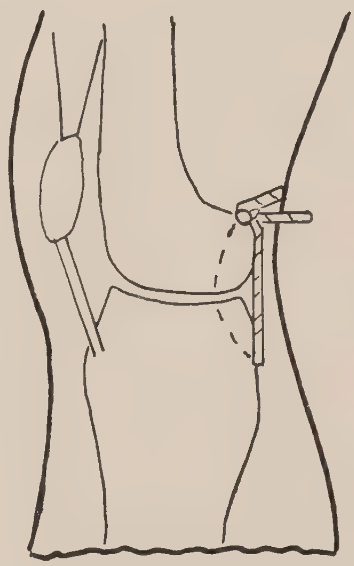

Fig. 111.—Bartow silk ligament at the knee, posterior ligament in place.

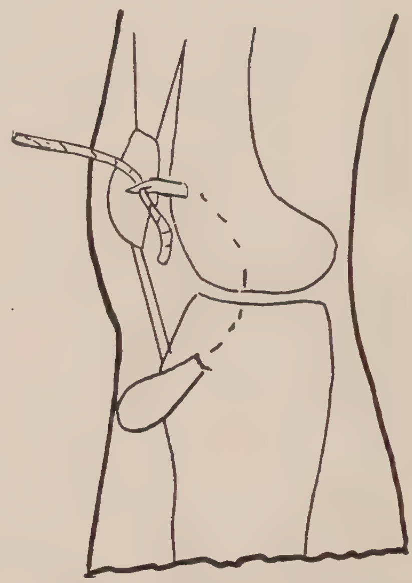

Fig. 112.—Bartow silk ligament at the knee, insertion of drill.

one-half inches from the middle of the tubercle of the tibia. The drill is pushed through the skin and bone at this point extending through the tuberosity of the tibia and upward (see figure 113), emerging at the top of the tibia into the joint; it next enters the lower surface of the femur and comes out anteriorly to the side of the patella. A piece of fine tough braided silk number 10 or linen thread is cut ten inches long, its two ends are threaded through the drill, the drill is withdrawn. This fine silk is used as a leader to draw the heavy silk through the bone. A number 18 silk is threaded through the loop of the fine silk and drawn through the bone double. The drill is next introduced subcutaneously at the lower incision and made to protrude from the upper incision. The silk is threaded through it and brought down subcutaneously out through the lower skin incision (see figure 113). We now have the silk extending through the tuberosity of the tibia, emerging at the top of the tibia into the joint, into the lower end of the femur and out through the anterior

surface of the femur and down subcutaneously in front of both bones (figure 113), to be tied in front of the tibia. In the same way a second parallel ligament is placed. There is then one to the outer and the other to the inner side of the patella. Where the knee joint is particularly relaxed, additional ligaments may be placed at the inner side and at the outer side of the knee joint and posteriorly (see figures 110 and 111). The knee is slightly hyperextended before tying the ligaments; they should be tied three times, double strands having been used for each ligament. The ends are cut about one-sixteenth of an inch long, the skin is lifted by means of forceps allowing the knot to slip below the skin and below the fat. The knot is compressed by means of a blunt instrument, in order that it may not be too prominent under the skin. No sutures are necessary. Any other operation to be done on the hip or leg should be completed before tying the ligaments at the knee. No strain should be allowed on the new ligaments after they are tied. When there is a tendency to hyperextension at the knee or when the knee joint is extensively relaxed, posterior ligaments are applied in a similar way but at the posterior part of the tibia, and at the posterior part of the femur, a small incision above and a small incision below is made through which the drill is applied to the bone.

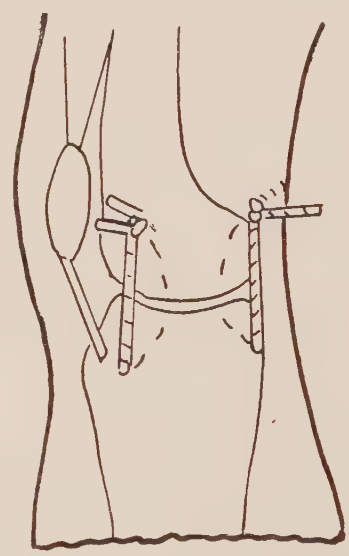

Fig. 113.—Bartow silk ligament at the knee, anterior and posterior ligaments in place.

Any lateral deformity or any permanent flexion should be corrected before inserting the ligaments.

An arthrodesis is preferable in very heavy patients with extensive paralysis or in young patients with an extensive paralysis as the patient may be heavier later on. But when there is some joint stability or a little muscular power these ligaments are satisfactory.

The after treatment consists of protection in plaster of Paris for eight weeks or longer; then a caliper splint is used until the patient is able to walk with confidence. The caliper then is at first worn loose, a little each day, then omitted a little each day until not needed.

CHAPTER IV

INCISION, PUNCTURES AND ARTHROTOMY

78. Operation for Displaced Semilunar Cartilage.—When operation is indicated for slight or considerable displacement of the semilunar cartilage, one of several incisions may be used. An esmark is applied and a tourniquet. The leg should be prepared and the field of operation well protected, the knee flexed at right angle preferably off of the end of the operating table as suggested by Mr. Jones. The protecting sterile sheets should include the foot and leg to above the calf. The upper sheets should extend down to a point two inches above the patella. The flexed knee hangs off of the operating table resting on a double sterile sheet which covers the other leg. After the skin incision, towels may be clamped to the edges of the retracted skin and a fresh knife and instruments used to complete the operation. A crecenteric incision (see figures 114, 115) is made directly downward one-half inch to the inner side of the patella down to the tibia, then curving at right angles along the upper edge of the tibia for two and one-half inches. The tissues are dissected up in one layer down to the tough fibrinous capsule for the full line of the incision. The flap is retracted inward and the fibers of the capsule incised leaving the synovial membrane unopened. Any bleeding points should be checked at this point. The synovial membrane is held up with a pair of forceps and nicked with a pair of scissors and then opened just above and parallel to the line of the tibia. This gives ready access to the semilunar cartilage. The inner semilunar cartilage is a little thicker through than the external, it is elliptical in shape, while the external semilunar cartilage is not as thick through, and is circular and longer. If it is loose or turned up it should be lifted with a pair of forceps and a pair of blunt curved scissors used to dissect it from its underlying attachment as far posterior as possible, but in no case should the lateral ligament of the joints be cut to make the removal more complete. The joint should in no other way be interfered with. All but the most posterior portion of the cartilage is removed. Any bleeding in the joint is checked by hot saline solution on cotton pledgets; fine catgut or silk is used to close the synovial

Fig. 114.—Incision for semilunar cartilage, made with knee flexed.

Fig. 115.—Anterior view of semilunar cartilage incision.

membrane. The joint capsule is brought together with interrupted chromic catgut sutures number 00, the skin, fat and fascia with interrupted chromic catgut number 00. A splint or plaster may be used for three days. After that no apparatus should be used.

Small degrees of motion are encouraged after the fifth or seventh day. The patient is up on crutches at the end of two weeks, and weight bearing allowed at the end of the fourth week. The surgeon should be guided by the amount of swelling. When it is possible to handle the tissues carefully at the time of operation surprisingly little reaction occurs from the operation.

79. Operation for Torn Crucial Ligaments at the Knee.—Injury and repair of crucial ligaments. The damage is readily detected when operating for deranged condition of the joint and any tear repaired with quilted silk sutures. The motion of the crucial is then tested with the knee flexed and extended. See figure 117.

The anterior crucial ligament extends anteriorly from the inner to the outer side obliquely. The posterior crucial ligament extends from the outer side to the inner nearly vertically.

The patient lies on his back, the operator stands on the side of the leg to be operated on. An esmark rubber bandage and tourniquet is applied, the skin having been prepared with scrupulous care as to aseptic detail, sterile sheets cover the upper third of the thigh and lower leg and foot from two inches below the tibial tubercle.

An incision is made in the median line starting four inches above the patella and extending vertically downward in the median line to just below the adductor tubercle. The dissection is carried down in one layer through the skin and fat, the edges of which are dissected up and retracted. At this point the operator if he wishes may additionally protect the incision by clamping sterile towels to the retracted edges of the skin and fat and use fresh instruments for completing the operation.

The incision is made to the bone over the patella; the muscle and tendon adjoining are separated in the median line above and below. A saw is used to separate the patella. When it is cut two-thirds through, the knee is then flexed and a chisel or osteotome is used to complete the separation. When the synovial membrane is opened above the patella, the operator carried the dissection upward, opening the joint cavity completely under the muscles laying bare the uppermost cul-de-sac.

The patella ligament is split separating it into two lateral halves, also the sub-ligamentous fat; each half of the patella is now retracted and the knee flexed allowing a good view of the joint and the crucial ligaments.

This incision will give a complete view of the synovial cavity anteriorly. Any deranged condition having been remedied, the knee is straightened, the quadriceps entensor and the joint cavity beneath it are carefully brought together with chromic catgut sutures number 00 down to the patella. Silk or kangaroo tendon is used to bring the soft tissues together immediately at the upper end of the patella and imme-

diately at the lower end of the patella. When for any reason these materials are undesirable or not available, chromic catgut sutures number 0 or 00 may be used. No sub-patella patella sutures are necessary; the halves of the patella are carefully adjusted and the sutures placed in the overlying fascia. Sometimes there is a little blood left in the joint but this will do no harm. As a rule washing with salt solution will remove any that is present. Any very small amount of free blood will not interfere with convalescence. The muscles and overlying tissues having been brought together with interrupted chromic catgut sutures number 00, the skin and fat are brought together with continuous chromic catgut sutures number 00. A posterior wire splint or a metal splint holding the knee very slightly flexed is applied and a plaster may be used over this. If a plaster is used it should be removed on the third or fifth day. Gentle motion is begun on the fifth or seventh day and as the patient progresses, he is encouraged to use the muscles and may be up with crutches at the end of ten to fourteen days. In the fourth week, he is encouraged to bear a little weight on the leg.

80. Arthrotomy.—A knowledge of the important routes of approach to the joints will facilitate any joint exploration, the removal of foreign bodies, the repair of traumatic conditions, the adjustment of difficult fractures, the reduction of old and difficult dislocations, to mobilize joints where motion is partially or totally lost, and to restrict or stiffen the joint as in certain paralytic conditions, to relieve and thoroughly drain suppurative conditions; a knowledge of the important routes of approach to the joint is very important. For each case, the operator will select the incision best suited for the individual condition. Joint operations should never be hastily considered and should be avoided by any one not familiar with the best surgical technique.

In all operations on the joints, the incision should be made down to the synovial membrane and large enough before opening the synovial cavity. All bleeding should be stopped and the synovia carefully opened. The joint structures should be tampered with as little as possible, the synovial membrane brought carefully together and the layers over it closed in order not to disturb the function of the periarticular tissues. Unnecessary separation of the tissue layers is to be avoided. Any ligaments that must be cut should be loosened periosteally when possible, in order that they may be easily replaced. Early motion should be the rule, gentle at first, and gradually increased.

81. Arthrotomy at the Knee.—Arthrotomy at the knee is indicated for certain internal derangement, for the removal of foreign bodies or loose bodies, derangement of the semilunar cartilage, suppurative conditions, fractures, etc. For a good view of the joint and complete exploration of the anterior cul-de-sacs an anterior median incision through the patella is the best. This will give an extensive view of the synovial pouches anteriorly, as well as all other anterior structures. The internal semilunar lateral incision is more useful for derangement of the inter-

nal semilunar cartilage; the external is rarely deranged, an external semilunar will give ready access to the outer semilunar. This cartilage is rarely the cause of trouble. For plastic operation the two longitudinal antero-lateral incisions are generally preferred. For excision or arthrodesis the semilunar or "U" shaped incision is used. For drainage, numerous incisions have been recommended.

The operator should not neglect the upper and lower parts of the synovial cavity anteriorly and the joint cavity behind in any extensive suppurative conditions.

For displacement of the knee cap which is usually displaced outward, an antero-lateral incision will allow the tears in the capsule to be remedied and give access to the patella tendon which should be displaced as described in these pages elsewhere.

For pre-patella bursitis a longitudinal incision just to the side of the bursa is used.

For fractures of the patella a long median incision is made or a lateral just to the inner side of the patella but long enough through the skin and fat to allow retraction and complete exposure of the patella.

82. Anterior Median Incision. Splitting the Patella into Lateral Halves.—This incision is useful where a complete view is desired of the joint and its anterior cul-de-sacs. It is useful for obscure internal derangement, for inspection and repair of the crucial ligaments, for the removal of loose bodies or pannus formation and for cleaning out the joint in septic conditions. It gives a wide view of the knee and the most complete. This incision is not the best for reaching the semilunar cartilages. There is surprisingly little reaction following this operation. See figures 116, 117.

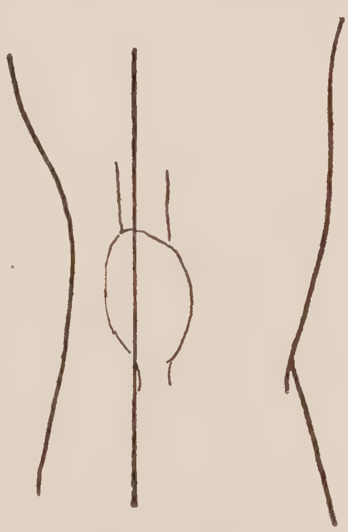

Fig. 116. — Anterior median incision.

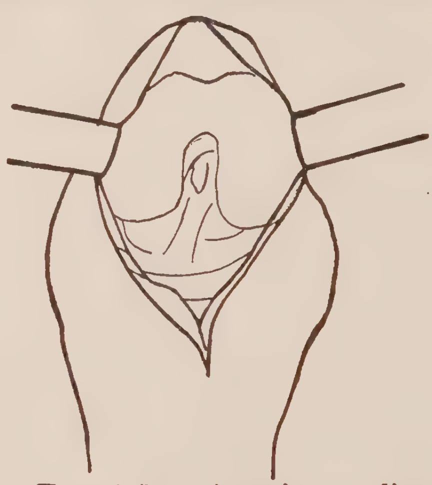

Fig. 117. — Anterior median incision retracted, knee flexed showing view of crucial ligaments.

The patient lies on his back, the operator stands on the side of the leg to be operated upon. An esmark rubber bandage and tourniquet is applied, the skin having been prepared with scrupulous care as to aseptic detail; sterile sheets cover the upper third of the thigh and lower leg and foot from two inches below the tibial tubercle. Occasionally the esmark and tourniquet may be omitted, if there is any reason for haste.

An incision is made in the median line (see figure 114), starting from the patella and inclining slightly to the inner side, four inches upward.

The incision extends over the patella and below, in the median line, to just below the adductor tubercle. The dissection is carried down in one layer through the skin and fat, the edges of which are dissected up and retracted. At this point, the operator, if he wishes, may additionally protect the incision by clamping sterile towels to the retracted edges of the skin and fat and use fresh instruments for completing the operation. The surgeon may proceed in one of two ways.

(A) Dissecting through the tendon above the patella, extending upward and inclining slightly to the inner side of the median line, then splitting the tendon below the median line before sawing the patella.

(B) Or the tendon above and below the patella is split a little way before sawing the patella.

With the leg straight the patella is sawed two-thirds through, the knee is now flexed forty-five degrees and a sharp osteotome used to complete the separation, then the tendon above is divided inclining to the inner side of the median line and the tendon below is split in the median line. A better exposure of the joint is possible if the patella is cut to the inner side of the median line as there is less mobility of the inner fragment (suggested by Dr. Brackett).

When the synovial membrane is opened above the patella, the operator carries the dissection upward, opening the joint cavity completely under the muscles, laying bare the uppermost cul-de-sac. The knee is flexed ninety degrees and the patella retracted laterally.

The patella ligament is split, separating it, also the sub-ligamentous fat. Each half of the patella is now retracted and the knee flexed allowing a good view of the joint and the crucial ligaments.

The dissection of the tendon above should be carefully made so that it may be accurately approximated afterwards. The fat pad under the patella should be split in the median line, and its ligament on the inner side carefully adjusted when the sutures are placed, bringing the fat pad together in its original position.

Any deranged condition having been remedied, or loose body removed, the knee is straightened, the quadriceps extensor and the joint cavity beneath it are carefully brought together with chromic catgut sutures number 00 working from the patella upward. The joint should be handled as little as possible. Silk or kangaroo tendon is used to bring the soft tissues together immediately at the upper and lower end of the patella. When for any reason these materials are undesirable or not available, chromic catgut sutures number 0 or 00 may be used. The halves of the patella are carefully adjusted and the sutures placed in the overlying fascia. No other patella sutures are necessary. Sometimes there is a little blood left in the joint. This will do no harm. As a rule, washing with salt solution will remove any that is present. Any very small amount of free blood will not interfere with convalescence. The muscles and overlying tissues are brought together with interrupted chromic catgut sutures number 00, the skin and fat brought together

with continuous chromic catgut sutures number 00; a dry dressing is applied. A posterior wire splint, holding the knee very slightly flexed, is used and a plaster may be used over this. If the plaster is used, it should be removed on the fifth day. Gentle motion is begun on the fifth or seventh day by pressing with the hand in the popliteal space and raising the knee, letting the heel rest on the bed. As the patient progresses, he is encouraged to use the muscles and may be up with crutches at the end of ten to fourteen days. In the fourth week, he is encouraged to bear a little weight on the leg.

When there is restricted motion in the knee, it is sometimes impossible or difficult to flex the knee without injury. In these cases, the patella is separated with the knee straight.

In the aged, or where the health is not good, when this operation is done for low grade painful suppurating conditions, it is often necessary to operate quickly and spend time in wiping out the cavity or in freeing it of foreign material. In these cases, the incision is made rapidly through the skin and fat as above described and dissected back only enough to recognize the tendons and to expose the patella. This is sawed rapidly two-thirds through. An osteotome is used to complete the separation. The upper synovial cavity is rapidly opened with a pair of blunt scissors curved on the flat side. The lower jaw of the scissors is entered into the joint above the patella and lifts the tendon and synovia, cutting it upward and extending slightly to the inner side of the median line. The tendon below is split through with the knife and the joint laid open completely. The knee is flexed at right angles. In these cases requiring haste, the joint is carefully treated. The important sutures are used, one or two in the sub-patella fat, a heavy one above and below the patella and a continuous chromic catgut suture 00 in the fibrous tissue over the patella. If there is time, the synovial cavity is closed slowly and carefully,—if not, it is sutured rapidly with the tendon by a continuous chromic catgut number 00.

If drainage is necessary, tubes are placed into large punctures at the side of the joint made before the incision is closed. This rapid operation has been done in patients over sixty years of age.

With a painful infected condition, requiring open operation, ultimate recovery is possible in some cases, with sixty to ninety degrees of motion.

Fig. 118. — Posterior incision five inches long, starting in the median line three inches above the joint line.

83. Posterior Incision.—The posterior incision is used for loose bodies in the posterior part of the joint or the removal of the exostosers, or for drainage when anterior and lateral drainage is not sufficient. A long vertical posterior median incision is made five inches long starting three inches above the joint line which may be felt in front. The incision is carried down

through the skin and fat for the full length. A blunt instrument is then used separating the tissues between the outer side of the vessels and the biceps and outer head of the gastrocnemius. The tissues are then retracted and the synovial membrane opened. See figure 118.

84. The Bayonet Incision at the Knee.—This incision combines half the outer and half of an inner vertical incision with a cross incision over the patella or just below it. Whether the upper or the lower half is outward is a matter of choice. In order not to weaken the inner attachments of the patella to the tibia the upper portion of the bayonet incision had better be made one-half inch to the inner side of the patella starting three inches above the patella, extending across the patella one-half inch to its outer side and then downward three inches (see figure 119). The cross incision is not made at right angles but inclines downward. In certain fractures and injuries this incision will be found of advantage. For a rapid excision in cases where the circulation is poor and the object of the excision is to obtain a stiff knee by grafting as well, this incision has many advantages. It is vertical and interferes very little with the circulation considering the size and the good exposure of the joint. The incision gives access to the tibia below, allowing a bone graft to be removed and placed across the excised joint, as suggested by Albee.

Fig. 119.—I. U-shaped and Bayonet incision at the knee. II. Bayonet incision; the upright portions should be one-half or one inch outside or inside of the patella. The horizontal portion may be over or just below the patella.

85. Two Lateral Incisions at the Knee (Fig. 120).—For exploratory arthrotomy or for suppurative conditions the median incision is preferable, but in certain fractures or operations on the tibia and femur or on both bones, one or two lateral incisions are more practical than the anterior median incision. In certain suppurative conditions where the median incision has been used to expose the joint completely, two short lateral incisions may be used for the necessary persistent drainage after closing the anterior median.

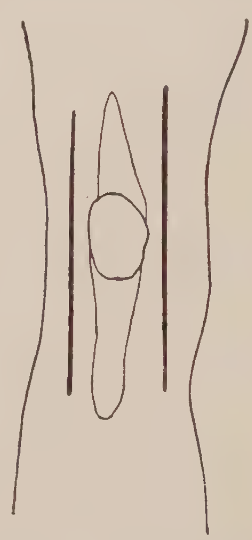

Fig. 120. — Two lateral incisions at the knee.

The lateral incision extends four to six inches on either side of the joint, one inch from the patella with their middle at the middle of the patella. These incisions are preferable for arthroplasty.

A longitudinal incision is made four inches long, one inch to the inner side of the patella, starting two inches above the joint. The incision is carried down to the bone. All the tissues are lifted subperiosteally from the femur and from the tibia, allowing a free exposure as the incision

is retracted forward, and backward. A second incision is made extending four inches above and three inches below the joint line and one inch to the outer side of the patella.

86. The U-Shaped Incision at the Knee (Fig. 119).—An outer incision is started three inches above the joint extending vertically downward one-half inch outside of the patella down to the level of the tubercle of the tibia and then horizontally across the tibia and extending vertically upward parallel to the first incision and one-half inch to the inner side of the patella extending to a point three inches above the joint. The incision is carried down to the bone if an excision is to be done. If the joint is to be opened and explored the incision is to be carried down to the capsule only. When the flap is retracted the synovial cavity is carefully opened.

87. Arthrotomy for Fractures About the Joints.—The necessity of immediate operation in fracture about the joints depends, as in other fractures, on the acuteness of the local and general reaction. When these do not contra indicate immediate operation, certain fractures about the joint may require treatment by the open method. Among these are fractures of the patella, fracture of the olecranon and certain fractures of the surgical neck of the humerus and certain fractures of the neck of the femur, all compound fractures, even when the protrusion of the bone has been extremely slight, all fractures that cannot be maintained or where apposition is impossible, many fractures combined with dislocation, articular fractures with pieces locking or limiting the joint action.

Where there is a great deal of trauma and in multiple fractures and in cases where there is a great deal of shock all that can be done is to immobilize the parts until a favorable time for operation. In selecting a suitable time for operation when it is found necessary to operate on a fracture if there is no immediate contra indication, the sooner it is done the better. Where there is tremendous swelling the surgeon should always wait. All cases should be operated on that show no union after three months of good treatment.

Methods of treating the individual fracture cannot be considered in a limited space like this. The writer has described the routes of approach to the different joints and the technique of these. This will enable the surgeon from his knowledge of fractures to select the route best adapted for the individual treatment required and when necessary two or more incisions may be used. A knowledge of the technique will enable the surgeon to work rapidly in reaching the fracture on which he expects to spend time.

88. A Method of Treating Overlapping Fractures.—Where the bones overlap, an excellent method of treatment is one suggested to the writer many years ago by Dr. Edward Martin of Philadelphia. In the operation when the surgeon has reached the fracture the ends are freed. A tough tape or webbing is used ten or twelve feet long, sterilized. The

two ends of the tape are tied together, a loop of the tape is placed over the distal end of the bone. The other end of the tape is thrown over the foot of the operating table, a thirty-five pound weight is attached to this by an assistant. In about five minutes the bones will be found to be separated at least one inch. The weight is then held up by a non-sterile assistant, the tape taken off of the end of the bone and clamped to the sheet on the operating table, so that it will not slip away while the surgeon works on the fracture. When the muscles are in fairly good tone or the overlapping of bone has been great, it will be found that the bones will overlap again in four or five minutes. A re-application of the tape will separate the bones again for the same length of time. The end of the lower bone should not be cut or freshened until all other procedures are done which require separation of the bone. When these have all been done the end of the bone over which the tape has been placed is freshened. After this the tape should not be placed on the end of the bone, unless it is very necessary, but the two ends allowed to come together and held by a clamp until the operation is complete.

Very bad overlapping fractures have been treated in this way in fresh cases without the necessity of shortening the bone. In old fractures no more bone need be removed than is required by the conical condition of the ends of the bone.

89. Fractures of Long Standing Still Ununited or United with Deformity, Preventing Function.—In fractures of long standing where there is a mild infection, conservative treatment should be tried first. When this has been tried free drainage should be established and at the same time the ends of the bone freshened up slightly. Unless the infection is marked, in many of these cases when the infection disappears, union has also taken place. In any case where there has been infection, no plastic operation should be used until the infection has been entirely absent for at least nine months, a year is safer. Where the infection is very mild and of long standing, during the process of treatment the patient may be allowed to walk on the other leg if the local reaction is not too great. Sometimes he may walk a little on the affected leg. It is of advantage in certain cases to use a Thomas splint to take some of the weight off of the affected leg, the patient being allowed to bear weight on the ball of the foot, the splint taking all the weight off of the heel. Where the x-ray shows conical bone ends it is practically useless to expect union without surgical interference.

90. Fracture of the Patella.—Fractures of the patella usually require treatment by the open method. Where the fracture is not compound the joint should be disturbed as little as possible, the fragments adjusted and sutured, if possible, by absorbable material. The suturing of the patella may require drilling the bone. The drill holes should not be made through to the under surface of the patella but from the fracture to the front of the patella. Multiple irregular fractures are often

very difficult to treat. Too perfect adjustment at the expense of excessive manipulation is not desirable in extremely difficult cases. A simple transverse fracture may be sutured with kangaroo through the periosteum and overlying fibrous tissues. The knee should be kept straight in plaster three weeks and then gentle passive motion without force is instituted daily, allowing the heel to rest on the bed while the knee is being slightly flexed, and the plaster reapplied afterwards. The plaster is removed a part of each day after the fourth week and gradually omitted entirely. The patient walks on the leg with the plaster and crutches in four weeks.

91. Fractures into the Knee Joint.—Fractures and oblique fractures into the knee joint will often require open operation and adjustment of the fragments. Bone grafts, plates or phospho bronze or silver wire may need to be used. The lower end of the femur is accessible from the sides through vertical incisions just anterior to the condyles posterior enough to avoid opening the joint capsule. The upper tibia is reacted by anterior incisions.

92. Operation for Dislocation of the Patella.—When the patella is excessively loose and dislocates easily, the simplest operation is that described by Dr. Goldthwait "splitting" the patella tendon. The displacement of the patella is usually outward. It reduces itself but has torn the inner capsule which becomes stretched, giving a predisposition to future dislocation.

OPERATION

An esmark and tourniquet is applied, the usual preparation and protection of the field of operation is used. An incision is made three inches long to the inner side of the median line extending from the middle of the patella downward. The skin and subcutaneous tissues are retracted in one piece exposing the patella tendon. This is raised on a blunt instrument and slit longitudinally; the outer half is detached subperiosteally, slid under the inner half and reattached by quilted sutures to the periosteum to the inner side.

The deep tissues are brought together with interrupted chromic catgut sutures number 00, the subcutaneous fat with interrupted chromic catgut sutures number 00, the skin with continuous chromic catgut sutures number 00.

A small dressing is applied and a plaster of Paris bandage from the toes to the groin. It is split on both sides. Slight knee flexion is allowed in six weeks; walking with the plaster on in eight weeks. The plaster is gradually omitted after that.

93. Tapping the Knee Joint.—The most scrupulous aseptic precautions are necessary both as to the preparation and the protection of the field of the operation. The knee may be tapped under the vastus internus, the vastus externus or posterior to the outer border of the patella. The operator uses the other hand or has an assistant press the

swelling from the other side of the joint. This makes it easier to insert the trocar. It may be advisable to wash out each joint pocket separately.

When there is much effusion it is not difficult to reach the joint. The skin is drawn to the side so that the hole in the skin and muscle will be out of line when the needle is removed. If fluid is to be drawn, and other solutions are to replace it, the amounts should be carefully measured. Two good graduated metal syringes are used, one used to aspirate, one to inject. All of their parts should be tested beforehand. The trocar is made to enter the joint and then is connected with the syringe. As little air as possible should enter the joint. The trocar should be of large diameter as the fluid may be thick or flaky. When the patient is not anæsthetized for the operation it is often well to have a short flexible tube connect the trocar with the syringe. This should be fastened at both ends by silk ties so that it will not leak easily when pressure or suction is used. If the joint is to be washed out a definite amount of fluid is injected and the return measured in a sterilized measuring glass. When the process is complete the amount of fluid left in the knee joint should not exceed one and a half ounces. This amount will not cause pain or too much distension in an adult knee.

Dr. Murphy uses a formalin glycerine solution as follows:—Liquor formaldehyde 2% in glycerine, about ten drops of the formaldehyde to each ounce of glycerine. This acts very well in infectious synovitis. But it should not be used in arthritis deformans nor in old chronic arthritis.

The tapping may be done with ethyl chlorid or novocaine adreneline solution, 1%. The solution should be prepared twenty-four hours before it is used.

CHAPTER V

OPERATIVE TREATMENT IN CASES OF JOINT ANKYLOSIS

94. Excision of the Knee to Obtain Ankylosis.—An esmark rubber bandage is applied from the toes to the groin and a tourniquet applied at the upper part of the thigh. The esmark is removed, the skin of the leg prepared for operation, and the leg protected with sterile sheets. A bayonet incision (see section 84), or a U-shaped incision, is made starting two inches above the joint and one inch to the side of the patella extending vertically downward to the level of the tuberosity of the tibia, then horizontally across the tibia, and up on the side, one inch from the patella to a point one and one-half inches above the joint. The sides of the "U" should be parallel, and about one inch from the edges of the patella. The incision is carried down to the bone and the flap dissected up rapidly in one piece. The ligamentum patellæ is cut across or the patella may be sawed through; the soft tissues are dissected up from the femur. The tissues are removed from the bone preferably with the periosteum. The tibia is likewise exposed preferably subperiosteally and the tissues retracted. Any disease of the soft tissues is now cleaned away. The knee is next flexed acutely, the crucial ligaments cut and the joint surface brought into view. The lower end of the femur is brought forward by displacing the tibia backward, the soft tissues removed subperiosteally from its posterior surface. The upper end of the tibia is next brought forward by displacing the femur backward, the knee being flexed. The soft tissues are removed subperiosteally from the back of the tibia. There is no danger of injuring the nerve and vessels by this subperiosteal method. The operator should work carefully but rapidly. A thin slice is removed from each bone in such a way that when the bone surface will be brought together the knee will be flexed ten or fifteen degrees. The bones are held perpendicular to the table while the saw is being used, usually the tibia first. In children the epiphysial line should be avoided. Save as much bone as possible. The bones should be placed in line as viewed from the front and in 10 degrees of flexion.

When the operation is one for disease of the bone the diseased focuses are cut out with an osteotome or chisel in the healthy bone around the diseased cavity, the cavity is chiselled out carefully, and all the disease removed. It is better not to use a curette for this purpose. The slice of bone removed from the tibia or femur need not be thick if the cavities are chiselled out. There is very little shortening of the leg by this method.

When the operation is done not for disease but to stiffen the knee,

only a very small slice is removed from each bone. After removal of the bone, the tissues are washed with hot saline solution and the tourniquet loosened to allow any bleeding points to be caught and tied. When it is necessary to remove a good deal of bone with the saw, the tissues must be very completely dissected away subperiosteally from the front and back of the tibia as well as from back and front of the femur so that they may be retracted allowing fully an inch of the bone to protrude denuded of periosteum.

In fitting the bones together, any tendency to bow leg or knock knee should be corrected. The operator should repeatedly notice the position of the foot and the direction which it is pointing before he removes the bone from the tibia, as it is very easy for the tibia to be inwardly or outwardly rotated during the operation. The bones are placed in apposition and may be held there by bone graft from the same leg by bone plates by kangaroo or silver wire sutures. The bone apposition should be very perfect and the bones held firmly together in order that perfect union will be obtained. The operation should be done without any unnecessary waste of time. The deep tissues and periosteum are brought together with interrupted chromic catgut sutures number 00, the deep tissues with interrupted chromic catgut sutures number 00. A posterior metal or wire splint properly padded and bent to the desired angle made ready before the operation is now applied directly to the leg. A plaster of Paris is applied over this including the foot and extending well up into the groin. This should remain in position for at least four weeks. The dressing is inspected through a window cut in the plaster.

Weight bearing is allowed in the fifth or sixth week if there is no disease and very little reaction at that time. When the operation is done to remove disease there is often too much reaction for weight bearing for a long time after the patient is allowed to be up and about. In the severe cases there is sometimes sinus formation but the ultimate healing occurs in a much shorter time than if the operation were not done. In these cases, weight bearing will not be tolerated so early.

Excision of the knee is rarely necessary after injury. Where there is flexion deformity, a McEwen osteotomy is preferable to any operation on the joint. This is especially so if there is any motion in the joint.

Excision or erasion of the knee joint may be used in paralytic cases to give a stiff knee when there is no power in the muscles. Before doing an excision for disease of the bone, conservative treatment and drainage should be tried first.

It has been recommended to transfer the posterior muscles to the side of the knee to prevent any tendency to flexion or subluxation. This should not be necessary and will prolong the operation which is usually done on patients with lowered local or general conditions or both.

95. Arthroplasty for Ankylosis of the Knee.—Ankylosis may be bony, cartilaginous or fibrinous, it may be periarticular, ligamentous

and capsular, or extra articular, that is, skin scars, tendons, fascia, nerves and arteries.

The form of ankylosis that exists will determine the treatment. A partial ankylosis at certain points had better not be treated by an arthroplasty.

Age must be considered, also the general condition of the patient. When the ankylosis is bony, cartilaginous or fibrinous, arthroplasty is indicated. When the condition is periarticular or extra articular, it may be treated by capsulotomy, tendon elongation, excision of exostosies, etc.

Dr. Murphy lays stress on the following points:—The principles of asepsis to the finest detail are absolutely essential. One not familiar with the best surgical technique should avoid arthroplastic operations. The exposure of the joint must be generous and complete. The contracted capsular ligaments and soft parts must be freed and if necessary lengthened. The normal contour of the joint should be restored as near as possible. The operator should obtain a hyper-mobilization of the joint. The joint should be re-shaped to give stability. The interposition of material to prevent reunion of the bone is necessary.

The principle is to separate the bones and to interpose between them material to prevent ankylosis. The best material for this purpose is the human pedicle composed of fat, muscle, fascia or a combination of these.

When this is not possible, a transplantation is made of fat and fascia from the trochanter bursa region or from the fascia lata.

Materials such as ivory, celluloid or silver are not good. Materials that will not absorb or that absorb too slowly are not desirable.

During the operation the soft parts should be freely liberated. Attach the interposing flap to one bone only and cover it completely. Early motion, that is, at the end of five to seven days, is necessary with or without gas or gas and oxygen.

Dr. Murphy records failures in arthroplasty as due to first, insufficient and defective exsection of the capsule and ligaments, second, insufficient interposition of fat and fascia between the separated bony surfaces, third, infection, fourth, the sensitiveness to pain on motion after operation.

Cases of primary tuberculosis and cases of recent infection that have subsided are not suitable cases for arthroplasty. In operation, in addition to the usual protection of the field of operation, after the skin and fat have been incised, towels should be clamped to the edges of the skin as an extra protection.

The knee is the least favorable joint for arthroplasty. Operations on the knee are very difficult because of numerous factors. Among these are the peculiarity of the joint and the fact that not only motion must be obtained, but good weight bearing qualities. There must be firmness and yet free use. For this reason if the ankylosis is only partial and the knee is permanently flexed it is better in these cases to do a McEwen osteotomy above the abductor tubercle as described elsewhere in the

pages and in this way straighten the knee without trauma and give the patient a straight leg with the benefit of the motion which he had before the operation (see Osteotomy at the Knee, section 54).

When the ankylosis is complete and requires an arthroplasty (see General Considerations in Arthroplasty), the following operation is described as outlined by Dr. Murphy.

OPERATION

The patient lies on his back, the operator stands on the side of the leg to be operated upon. The field of operation is properly protected and the leg below the knee so covered by sheets that the knee may be manipulated without disturbing the protection.

A longitudinal incision is made four inches long, one inch to the inner side of the patella, starting two inches above the joint. The incision is carried down to the bone. All the tissues are lifted subperiosteally from the femur and from the tibia, allowing a free exposure as the incision is retracted forward, and backward. A second incision is made extending four inches above and three inches below the joint line and one inch to the outer side of the patella. The subperiosteal dissection is continued around to the outer and anterior side of the femur and tibia. The posterior part of the joint is not disturbed; a curved chisel is used to separate the two bones and give them the normal contours. A cavity is made in the tibia to receive each condyle and deep enough to permit extension. An exaggerated intracondylar notch and ridge are made.

A " U " shaped incision may be used instead of the lateral, the sides of which are either side of the patella, extending one inch above the top of the patella, and going down and curved one inch below the patella. The skin and fascia flap are made carefully without disturbing the pre-patella bursa; the base of the flap is upward.

A pedicle flap is made from the vastus internus and another from the vastus externus. These are placed over the condyles and between the patella and the condyles.

If the operator prefers, he may use two rectangular flaps two and one-half inches by three and one-half inches, composed of the capsule and the subcutaneous fat with a base downward attached to the tuberosity of the tibia below the line of joint. This will include all the lateral capsule, fat and fascia.

As to the choice of incisions, the two lateral incisions are preferable to the " U " shaped.

The pedicles for arthroplasty at the knee may be taken from the vastus internus and externus as described above with the pedicle upward, or the fascia over the muscles may be split from above downward into two parts and folded over the joint and joined at the middle of the joint and under the patella. The flaps are separated with a blunt in-

strument from the overlying skin and fat and folded in between the bones. If the patella has been adherent it may be rotated one hundred and eighty degrees without disturbing the pre-patella bursa. The upper end of the patella may need to be trimmed with bone forceps to render it smooth and level before it is turned. When the vasti are used in this instance, the vastus internus and the vastus externus are sutured to the opposite sides of the quadriceps from which they are freed. This attachment will prevent the slipping of the patella. Baer has used successfully chromicized pig's bladder prepared for arthroplasty.

Free fascia flap

The operator may choose to cover the under side of the patella and the whole of the articular surface with a free fascia graft taken from the fascia lata. This is attached without rotating the patella. The flaps are sutured to the patella ligament and to each other in the median line. They are then sutured to the posterior capsule which has not been disturbed and should cover the tibia completely. When a free fascial transplant is used, it should be at least three and one-half by five inches. It should extend up under the patella. A carpenter and cabinet maker chisel, curved and straight, will give the best tools for shaping the joint. The normal outlines will tend to prevent luxation. The operator should be sure that the line of the leg is straight, and should remove sufficient amount of bone so that pressure between the bones will not cause necrosis of the transplanted flap. A wire splint or a Buck's extension with twelve pounds' weight is used after operation. Active and passive motions should be begun early. The patient is kept in bed for seven to ten days with this apparatus.

CHAPTER VI

OPERATION IN SUPPURATIVE CONDITIONS

96. Suppurative Conditions at the Knee.—In suppurative conditions at the knee joint if it is necessary to expose and wipe out the whole joint an anterior median incision will allow the most complete inspection, irrigation and wiping out the cavity. When this incision is closed the pouches on either side and above the patella should be drained by punctures two inches long. Drains on either side of the patella may be used but should be avoided if the others are likely to prove sufficient.

At the time of operation two lateral incisions may be necessary in those cases that require thorough irrigation, and tubes are inserted laterally. The important parts of the capsule are very little injured by the median incision with lateral drainage and the operation is just as quick and much more thorough than by two lateral incisions.

If the patient will not stand a complete operation, two incisions are made vertically on either side of the patella for drainage only, tubes are placed to each joint pocket and gauze is used to gap the angles of the incisions. These remain for ten days and then are shortened. See last half of section 82.

A plaster of Paris bandage is applied with large windows as shown in figure 449. Plaster ropes are used to connect two plaster cuffs, one at the thigh, the other on the calf of the leg. Large wads of sheet wadding are placed about the joint to hold the plaster ropes while they are being applied. When the plaster is cut away exposing the plaster ropes the extra sheet wadding is removed leaving the joint exposed for inspection and drainage. See Carrell method, section 323.

97. Osteomyelitis.—In osteomyelitis an operation should be done as early as possible after making the diagnosis. In sub-acute cases, incision and drainage are all that is necessary. Whenever incising for abscess all the pockets should be opened and if the abscess is large, counter incisions are made at dependent places. The pus pocket should be opened freely, wiped out with gauze, irrigated and wiped out again with gauze. Curetting should be avoided excepting for the removal of sinuses in the skin and in cases of sinuses it is often better to excise them. Perforated rubber tubing should be placed to drain the deepest portions of the pockets. The skin, fat and superficial muscle layers should be made to gap by means of gauze drains. At the end of ten days the gauze is removed and the tubes shortened. The tubes are gradually drawn out a little each day or two until not used. This method makes the repeated reapplication of drains and wicks

unnecessary as the wound will gap of itself and close from the bottom if the surgeon has been careful to make large incisions.

Where the periosteum is found destroyed or the pus under the periosteal layer, the bone should be opened by means of a large drill or a small gouge. Where this is necessary, the incisions should be large and the counter incision should be made on the other side of the bone with a hole made in the bone a little above or a little below the hole on the opposite side (figure 65). These holes in the bone should open up the medullary cavity. They should alternate on one side and the other as far up and down as the disease is suspected. When the abscess is very great and the bone involvement is large, a number of good sized holes should be made with a Burr drill or a curved gouge on both sides of the bone as shown in figure 66. The wound should be gaped widely;—the skin, fat and superficial muscle held open by large gauze drains. The tubes should reach from the surface to the deepest portions of the abscess cavity. Splints should always be applied to immobilize the limb. They should be placed so that they will not interfere with the dressing. In some instances it is better to apply plaster with large windows and ropes to give stability as shown in figure 449. The dressing should be done every day or twice a day, depending on the foul condition of the discharge. If the odor is excessive, chlorinated soda dressing should be used diluted $^1/_2$, $^1/_3$ or $^1/_4$ the U. S. P. strength. The gauze drains should be left for at least ten days without being disturbed. When removed, granulations will be formed under them in such a way as to keep the wound open without applying the drains. Irrigation may be used at the time of operation and the wound thoroughly wiped out with gauze afterward. No irrigation or probing or application of wicks will be necessary if the first drain is left in long enough. After the first ten days the tubes are shortened up gradually until they are not needed.

Much may be expected in the future from the Carrell-Dakin solution and technique. See section 323.

In severe cases where the patient is unconscious or delirious, the bone should be always open, three or four holes on either side made with a good size Burr drill. In no case should the incision be made only on one side of the leg in severe cases. No tight packing should be used as this interferes with good drainage. Where sequestra have formed they should be removed. An x-ray should be taken whenever possible to determine the position of the disease (unless the case is urgent and an immediate x-ray is not obtainable).

In cases of long standing that are sub-acute at the first examination, where the bone is riddled with holes over an extremely long area, it is impossible often to remove the dead bone satisfactorily without removing all the bone. In these cases free incision down to the bone with frequent openings into the bone as described above, will allow the septic process to run its course and the sequestra to gradually separate. We have had

some cases in which the lower third of both femora were riddled with holes and full of sequestra, the patient being in no condition for extensive operation, and yet not very ill. In these cases, however, if the surgeon had seen the patient in time an early operation would have prevented this extreme condition.

Sometimes it is necessary to close a large bone cavity which will not heal over. Where the process is distinctly septic no plastic operation should be done without first doing an operation to eliminate the septic condition. After that part of the muscle may often be transferred over such a cavity after it is closed. In transferring a muscle over such a cavity it should be freely transplanted and held there without tension. The skin should be brought together over the muscle and the wound drained, as there is apt to be inflammatory disturbance.

Where sequestra are present it is always desirable to remove them as soon as they have separated and the involucrum is strong enough to act as a support. Sequestra may be superficial or in the medullary cavity or both. Where there is a persistent sinus and a sequestrum is present, pus will continue to form until the sequestrum is removed. Cases discharging several years where a sequestrum is present may close in a few weeks after removal of the sequestrum.

In closing a bone cavity its edges may be chiselled clean and then the bone incised a short distance from one edge and parallel to it, the incision is carried down to the medulla, the incision in the bone is widened by prying it open and forcing the bone together closing the old cavity. This is sometimes a satisfactory method of closing an old open bone cavity which has sclerozed edges.

98. Excision of the Knee in Suppurative Conditions.—When an excision of the knee is indicated on account of the failure of conservative methods and the case is growing progressively worse in spite of good drainage, the operation is performed as rapidly as possible in order to diminish the shock due to a prolonged operation.

The technique is the same as that described under excision and arthrodesis when the tibia and femur are sawed across. The diseased cavities in the bone should be removed with a chisel or an osteotome, cutting them out wholly in the healthy bone. There will be just as good repair and less shortening by this method. Before placing the bones in apposition to obtain ankylosis, small holes should be drilled from the anterior or lateral surface of each bone to the cavities chiselled out if they are deep. This will insure good drainage. Drains should be used in all suppurative conditions. The joint should be immobilized after operations on the knee joint or its vicinity.

98a. Methods and Principles of Drainage in Acute Non-tubercular Suppurative Joint Disease. Knee, femur, tibia.—A small suppurative focus without virulence or active constitutional disturbance should be drained by a suitable incision wiped out with gauze, a tube placed to its deepest part and the soft tissues gaped with gauze.

When there is a great deal of constitutional disturbance drainage and counter drainage should always be the rule. If the bone is involved this should be opened and counter opened as shown in figure 66. The pus cavities in the soft tissues should be wiped out. No extensive bone operation should be done otherwise. The bone should be drained with tubes to the remote portions and the muscle, fat and skin gaped by gauze. The operation is done quickly and should not be prolonged, but efficient drainage and counter drainage should be established unhesitatingly. It is rarely necessary to do more at this time. If there is a marked sequestra formation this should be removed, but this had better not be done at the time of instituting drainage when the patient is nearly exhausted from an acute process. Any future operation made necessary should give good drainage and the removal of the sequestra if present and separated.

Any extensive non-tubercular suppurating bone disease about the knee, tibia or femur shaft should be drained by two long lateral incisions. If the patient is very ill and the bone abscess not readily located, long incisions with large drill holes alternating in the bone should be made (figure 66). This should be done very rapidly and good drainage established.

In any chronic suppurating process the pockets in the tissues should be well opened and wiped out and the diseased bone well drained and counterdrained. Large incisions should be made with tubes to all dependent parts and large gauze pads used, gaping the wounds for at least ten days and then the tubes and wicks shortened. This method of treatment is usually very successful. It does not necessitate the constant reapplication of drains, so discomforting to the patient. Irrigations should not be used in the after treatment unless the Carrell-Dakin method is used. The gauze should be placed around rather than over the wounds. The knee should be immobilized after operations on the joint or its vicinity.

PART III—FOOT AND ANKLE

CHAPTER I

OPERATION FOR DEFORMITIES

99. Manipulating the Foot.—The patient is anæsthetized. Usually in manipulating the foot, the patient lies on his back, the foot is flexed and extended, adducted, abducted or pronated and supinated. Dr. Bradford has suggested a very convenient method of manipulating the foot. The patient lies on his abdomen (see figure 169), with the knee flexed. The table should be low; if not the operator may stand on a box or stool; a pillow is placed under the knee. One or two assistants hold the leg above the ankle, the operator grasps the ball of the foot in both hands. This method is especially effective as the operator's weight is above the foot, adding many pounds to the strength of his hands. The power of the hands or foot wrench is applied more directly to the joints of the foot without motion of the leg. The peronei should be stretched, the tibialis anticus, and posticus and the tendo Achilles; the terminal phalanges of the toes flexed, then the proximal phalanges, then the metatarsophalangeal joints flexed and extended with the foot at first in dorsal flexion and later with the foot in equinus. The operator assures himself that the motions of all the toes and the foot joints are normal. The foot is stretched with the hand or with one of the foot wrenches.

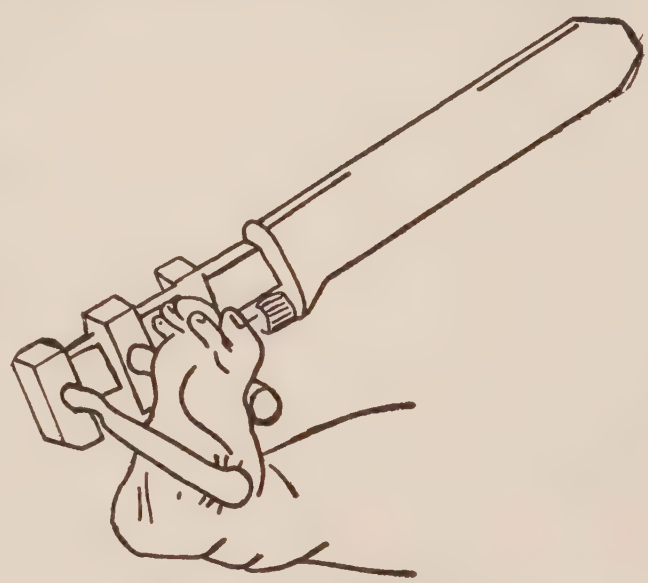

Fig. 121.—Thomas wrench applied to the scaphoid and metatarsus.

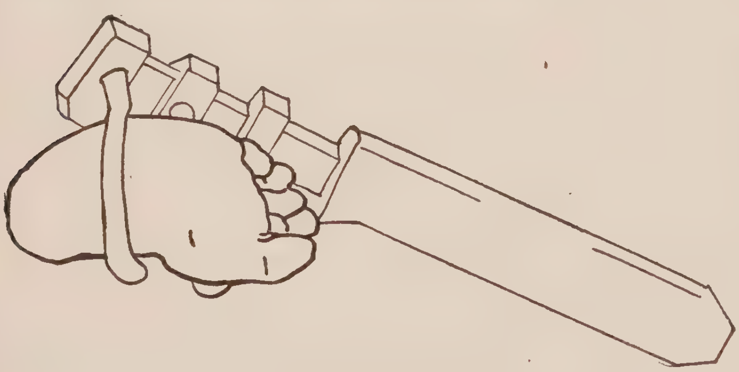

Fig. 122.—Thomas wrench applied to force the front of the foot down or up.

100. Manipulation of the Foot by Means of Apparatus.—When it is necessary to correct deformities of the foot, and do a tenotomy of the

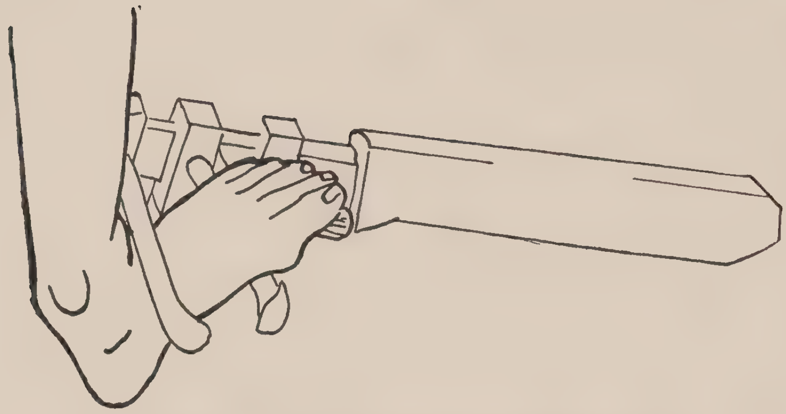

Fig. 123.—Thomas wrench to correct equinus.

tendo Achilles, the tenotomy of the tendo Achilles should be performed last. Stretching of the foot is best performed with the tendo Achilles intact. The joint is gently stretched and relaxed, the operator applying force gently in a gradually increasing manner until considerable force is applied and then relaxing until very slight force is used and finally relaxing entirely. In this manner a rhythmic stretching is kept up. No rough or forcible motion without a gradually increasing and gradually decreasing force should be employed. A joint that at first will seem almost impossible to move will often give way and straighten. When the front of the foot and other deformities are satisfactorily cor-

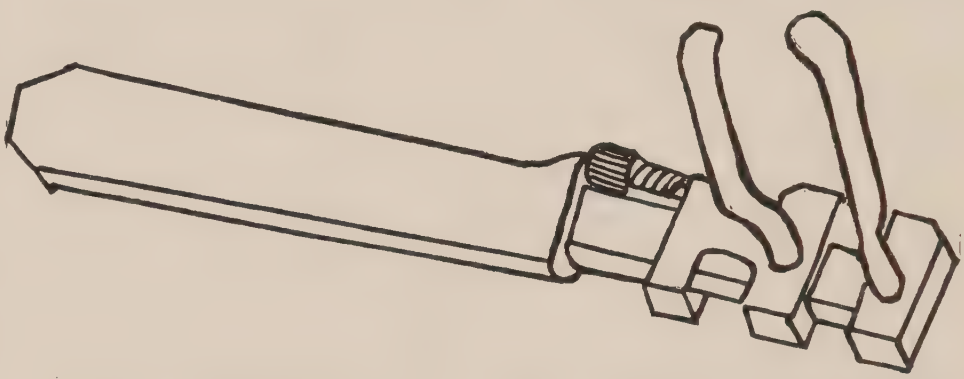

Fig. 124.—The Thomas wrench, used in manipulating the foot before or after operations on the foot. The wrench is nickeled and may be sterilized. The jaws that hold the foot are removable and vary in shapes (see figure 125) to fit the deformities; and to fit children's or adults' feet. By stretching with it a much less extensive operation is necessary.

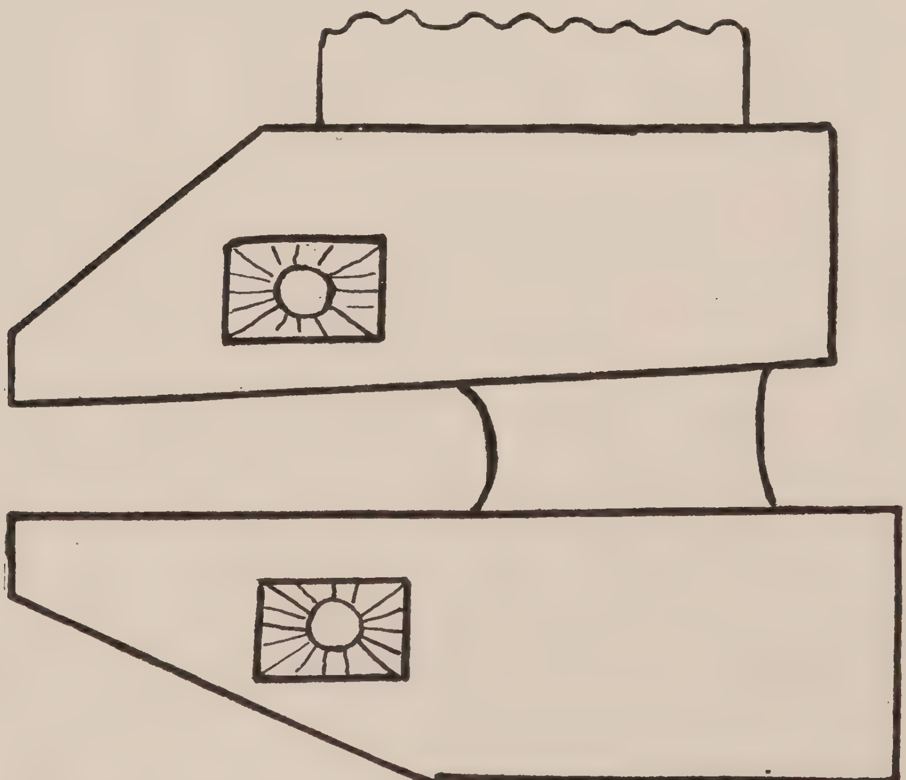

Fig. 125.—Thomas wrench, actual size of head of wrench; jaws fit in the squares.

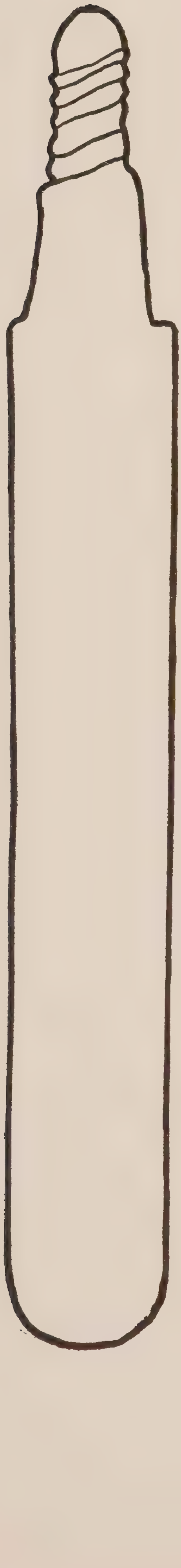

FIG. 126.—Thomas wrench, actual size of the flat side of each jaw.

FIG. 127.—Thomas wrench; two jaws with maximum curve like this, side view.

FIG. 128.—Two jaws with medium curve like this, side view. Thomas wrench.

FIG. 129.—Two jaws almost flat like this side view. Thomas wrench.

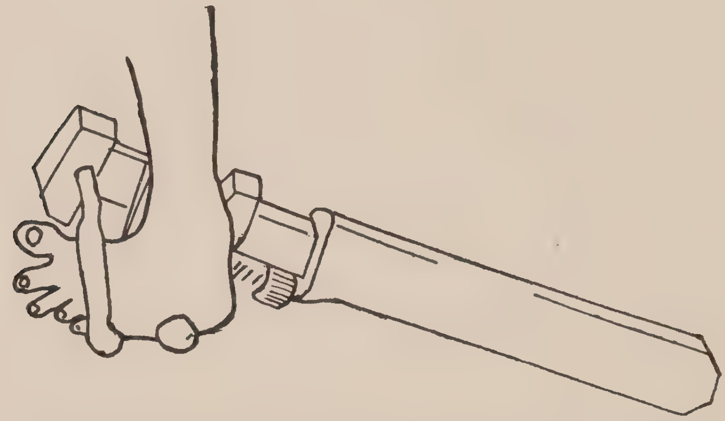

FIG. 130.—Thomas wrench applied to the metatarsus and cuboid.

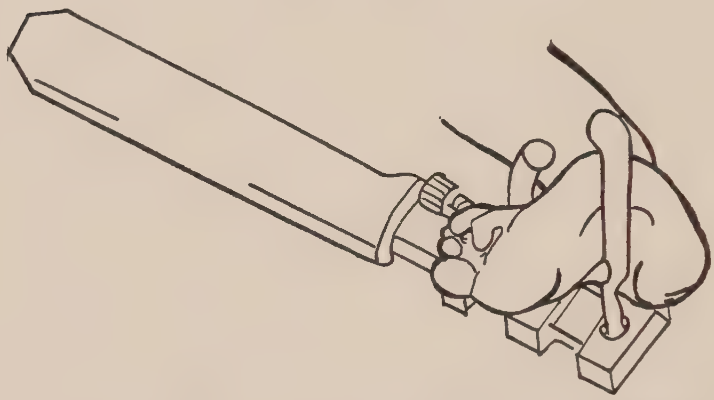

FIG. 131.—Thomas wrench applied to the astragalus and cuboid.

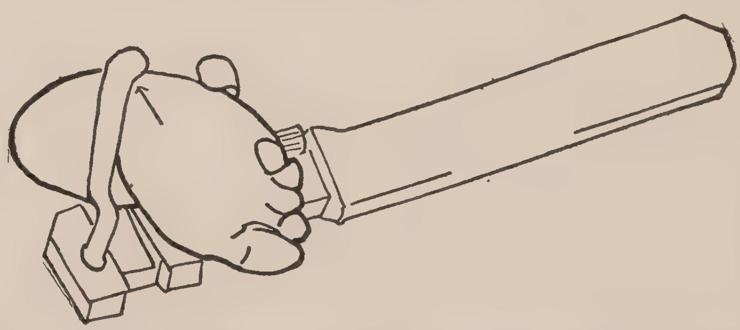

FIG. 132.—Thomas wrench to limber the tarsus at the cuboid.

FIG. 133.—Thomas wrench applied to correct varus.

rected, then the tendo Achilles may be tenotomized if necessary.

101. Manipulating the Foot by Means of the Thomas Wrench.—A very convenient wrench for manipulating the foot is known as the Thomas Wrench, represented in figure 124. It is a large monkey wrench fifteen inches long. The wrench has two arms which grasp the foot. These arms are six inches long. The exact length and dimension of these jaws are outlined in figures 124 to 129. They vary in size and contour and may be applied to the wrench in order to fit a large or a small foot. In the use of force to correct deformity, slight pressure is applied by means of the wrench and then the force relaxed. Slight pressure is again brought to bear by means of the wrench and then relaxed. With a rhythmic application of force, and then relaxation, the blood enters the stretching tissues and there is less danger of tearing them at any one point. Considerable force may be applied in this way, with less swelling after a forcible manipulation than if the parts are handled roughly. The stretching of a deformity should be slow and not violent. In applying the various mechanical foot stretchers, an extreme deformity which gives way very little at first will often yield entirely if the operator is patient.

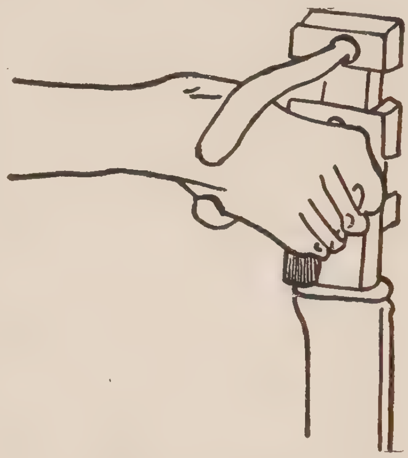

FIG. 134.—Thomas wrench applied to the scaphoid and cuboid.

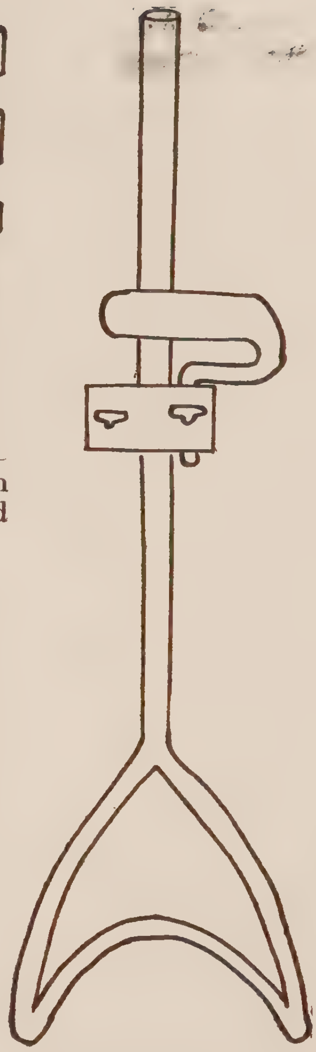

FIG. 135.—Dr. Bradford's club foot wrench. By using this wrench before or after operating on the foot a much less extensive operation is necessary. The middle section slides, adjusting itself to the size of the foot.

FIG. 136. — The great toe metatarsal hold used for the left foot, the other for the right; this one is detached, the other is in place. (See figure 135).

FIG. 137.—Single bar used as a lever to raise the cuboid.

FIG. 138.—Removable end of the wrench. When this end is removed the wrench fits easily in an ordinary instrument sterilizer.

Figures 121 to 134 represent the many methods of applying the Thomas wrench to the foot.

After any foot operation the

wrench will help complete the correction of the deformity and make more extensive operations unnecessary. These wrenches are especially

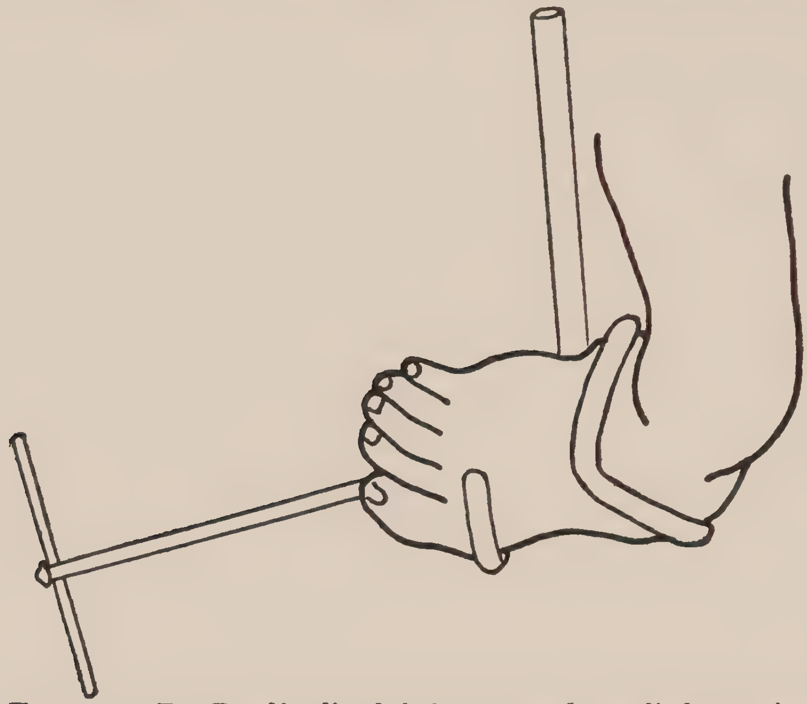

Fig. 139.—Dr. Bradford's club foot wrench applied, to raise the cuboid and abduct the foot.

useful in obtaining the normal range of motion in the foot before other operations.

102. Manipulation of the Foot by Means of the Bradford Wrench.—Figures 145 to 150 represent one of Dr. Bradford's club foot wrenches

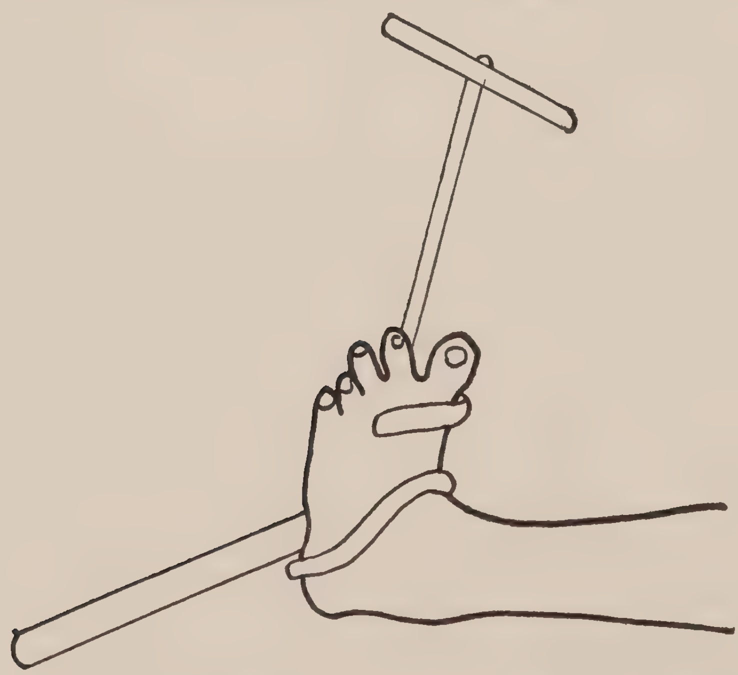

Fig. 140.—Dr. Bradford's club foot wrench, external view from above.

to correct deformity in the foot and ankle. While designed to correct club foot it readily adapts itself to the correction of the other foot deformities and to limber up the joints of the ankle and foot.

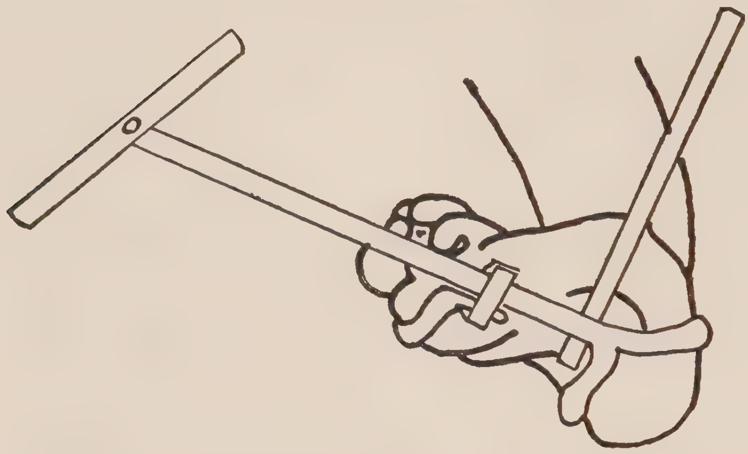

Fig. 141.—Dr. Bradford's club foot wrench, external view from below.

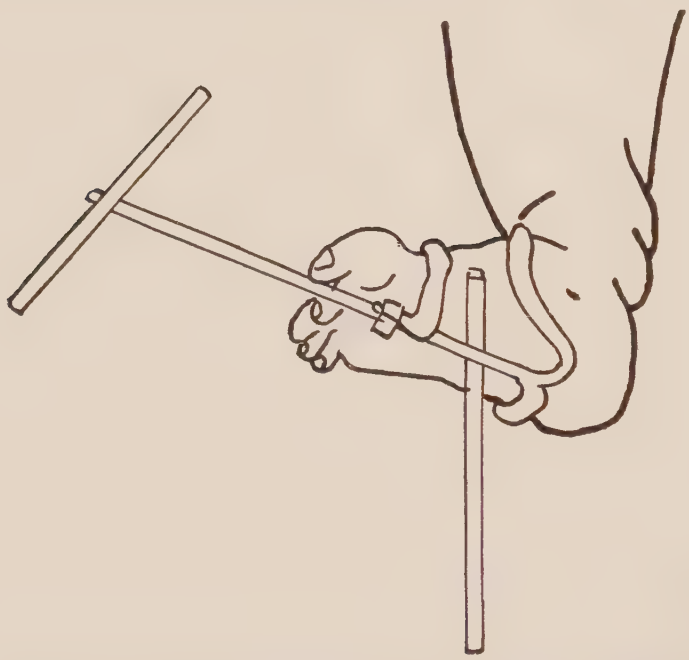

Fig. 142.—Dr. Bradford's club foot wrench, internal plantar view.

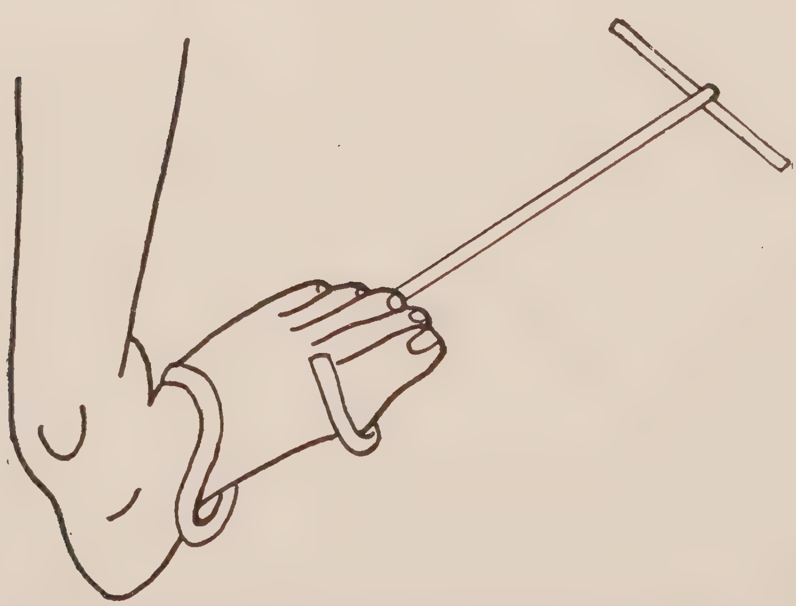

Fig. 143.—Dr. Bradford's club foot wrench, internal view from above.

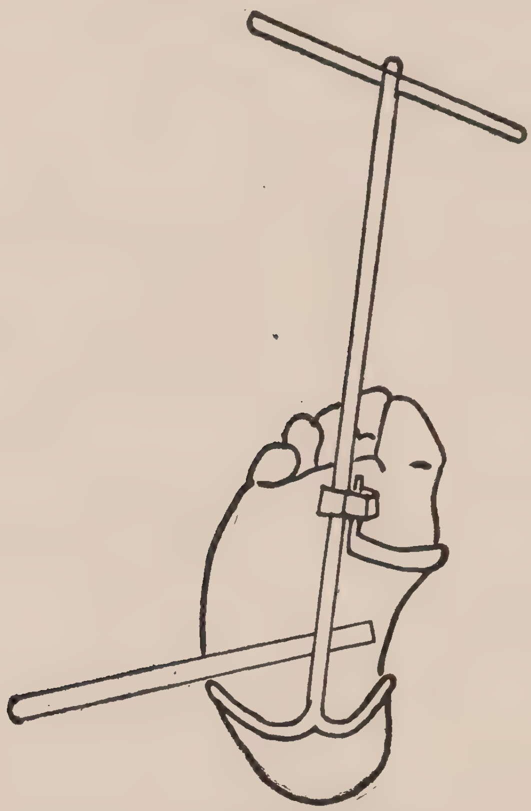

FIG. 144.—Dr. Bradford's club foot wrench.

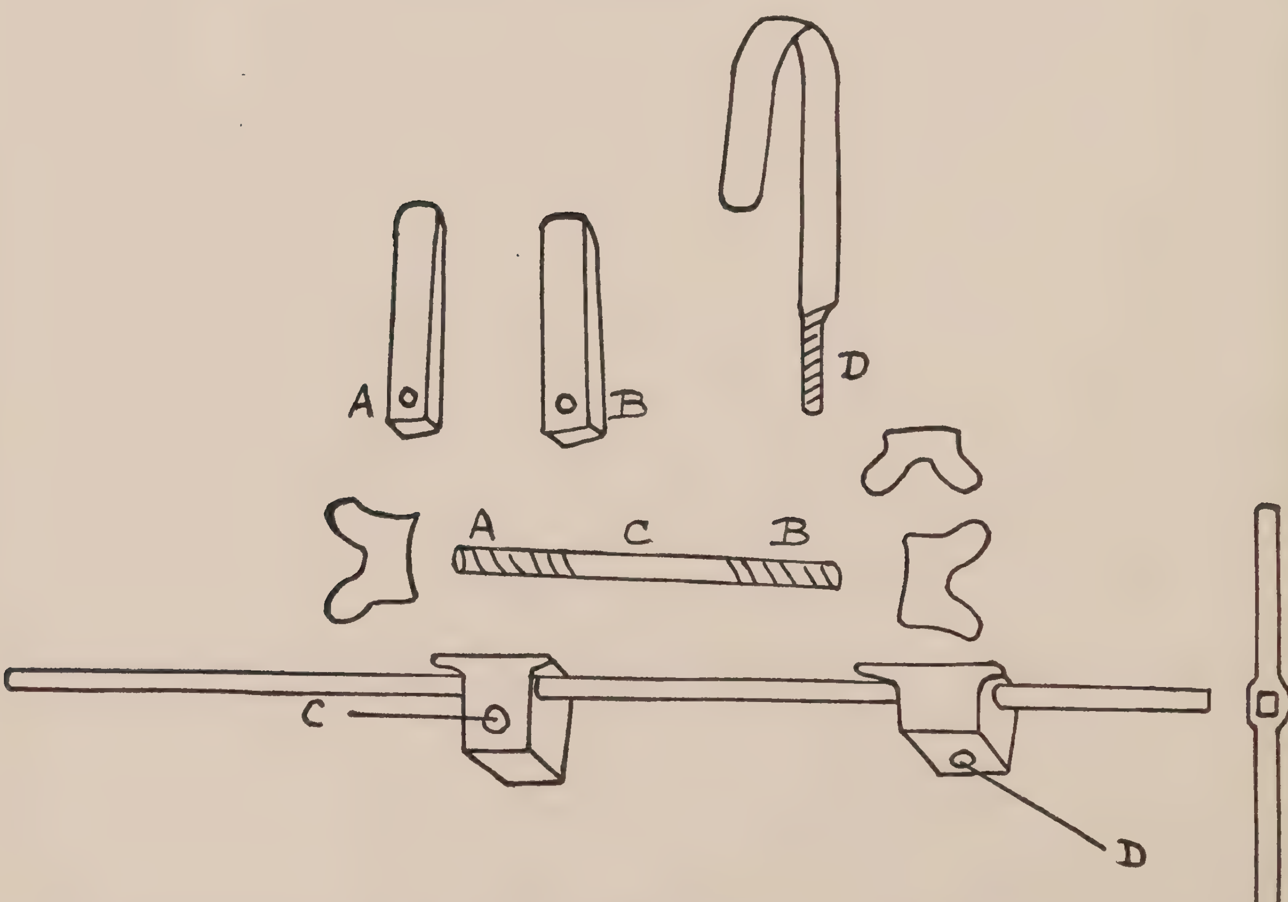

FIG. 145.—Another of Dr. Bradford's club foot wrenches taken apart; by using this wrench before or after operating, a much less extensive operation is necessary. A is applied to the bar C at A. B is applied to the bar C at B. The bar C is first applied to the hole C. The hook D is applied to the hole D. (See illustrations 146 to 150.)

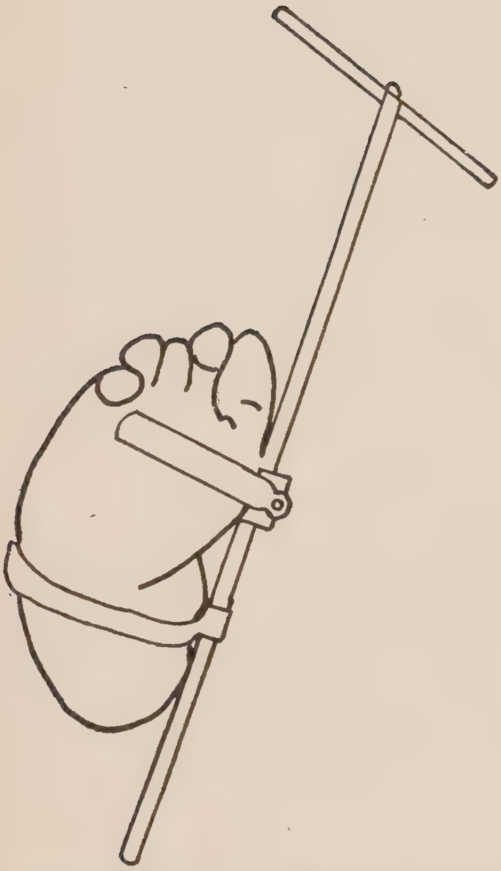

Fig. 146.—Dr. Bradford's other club foot wrench applied to the foot. Plantar view.

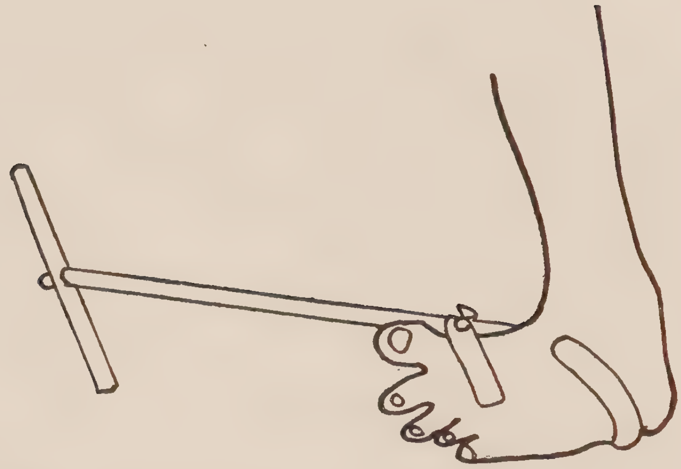

Fig. 147.—Dr. Bradford's other club foot wrench applied to the foot. External view.

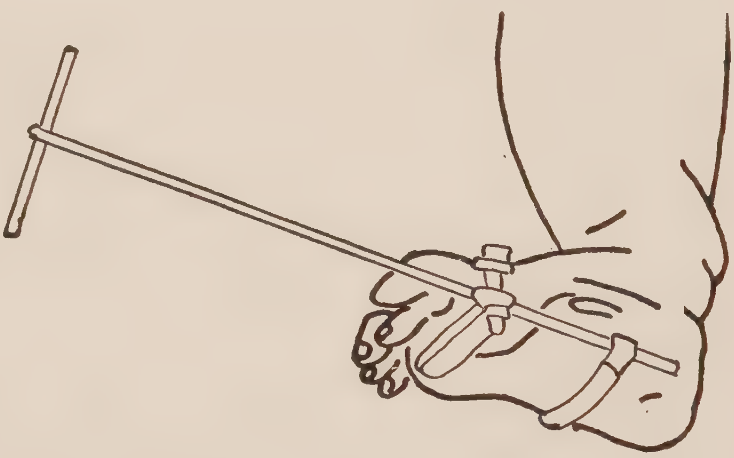

Fig. 148.—Dr. Bradford's other club foot wrench applied to the foot. Internal and plantar view.

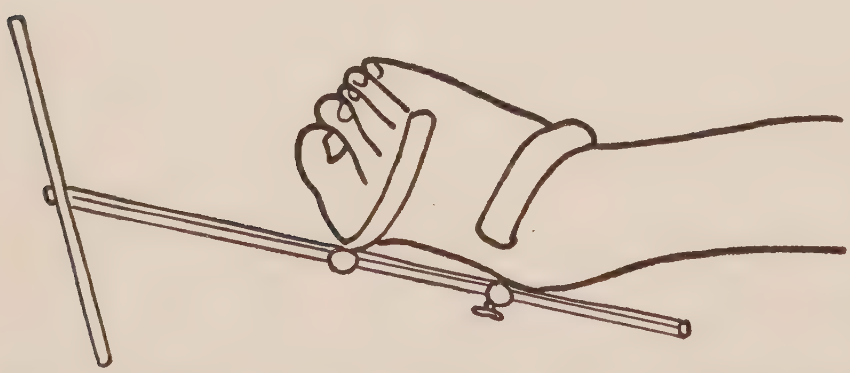

Fig. 149.—Dr. Bradford's other club foot wrench applied to the foot. Dorsal view.

They will also be useful in increasing the flexibility in the joints of the foot and ankle.

Another wrench of Dr. Bradford's (see figures 135 to 144) is used to correct the deformities of the foot. This wrench is useful to limber up the foot and help correct the ankle and foot deformities.

103. Manipulation of the Foot by Means of Dr. Davis Wire Foot Wrench.—Dr. Gwilym Davis' wire foot wrench (see figures 151–155), is used to correct deformities of the foot.

104. Operation for Talipes Varus, and Equino Varus, Club Foot.—A varus or equino varus (see figures 160–161) may be slight or extreme.

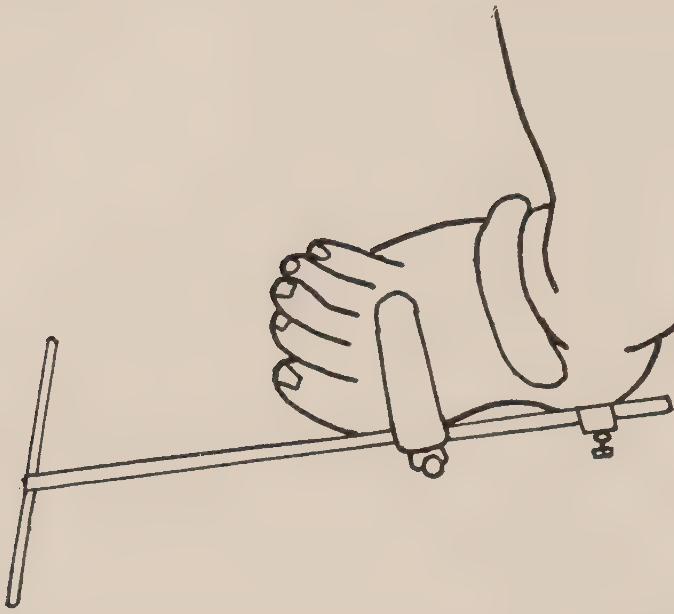

Fig. 150.—Dr. Bradford's other club foot wrench applied to the foot. Dorsal view with force applied.

Fig. 151.—Dr. Davis' wire foot stretcher applied, plantar view. It consists of a heavy inflexible iron wire and two webbing straps. Dimensions of the wrench. Length = 19½ inches. Width = 5 inches. Diameter of wire = 3/8 inches. Cross piece length = 7½ inches. Distance between ends of cross piece = 5 inches.

It may be due to over-strong tibialis posticus or anticus and long flexor of the toe tendons with weak peronei; or it may be due to relaxed peronei with not over-strong muscles on the inside of the foot, or the muscle may be paralyzed and the deformity due to lack of foot balance, or to uneven bony overgrowth, or lack of growth.

In some cases the deformity is acquired at the time when the patient begins to recover from a paralysis. After operation sometimes the weak muscles are made as strong as ever if the foot is overcorrected, and put in a position of valgus, followed by muscle training.

Fig. 152.—Dr. Davis' wire foot stretcher applied. Internal view.

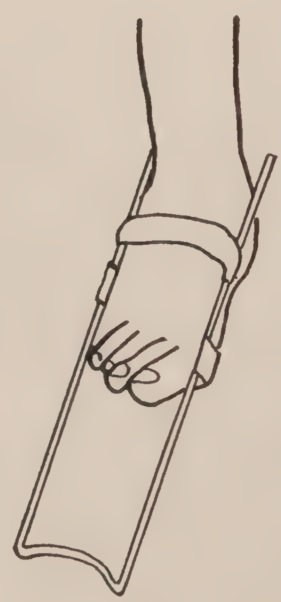

Fig. 153.—Doctor Davis' wire foot stretcher applied. Dorsal view.

When the correction of a varus or equino-varus cannot be maintained after proper relaxation of the contracted tissues and training of the peroneii, it may be necessary to transplant the tibialis anticus or the long toe extensors to the middle of the midtarsus region. This often is sufficient in slight

varus cases where the lateral stability of the foot is otherwise good. In a case where the posterior tibial muscles and the long flexors of the toes are extremely strong, the anterior tibial muscle must be put further to the outer side or one of the strong muscles transplanted forward and outward to balance it.

Before transplanting, the normal motion of the joint must be restored. Any tendency of equinus must be overcome by stretching and by a tenotomy. No transplantation should be performed unless the action of the ankle is free and the deformities overcome. Where the long flexor of the toes is extremely good, this muscle may be transplanted forward to restore the balance of the foot. (For a description of the transplantation of the long flexor of the toe forward, or of the tibialis posticus forward, the reader is referred to subsequent pages.)

Fig. 154.—Dr. Davis' wire foot stretcher applied. External view.

In transplanting the long toe flexor, or the tibialis posticus forward, it should be remembered not to weaken the joint by incisions around the malleoli. The tibialis posticus lies anterior to the flexor longus digitorum, but these tendons are best differentiated by pulling on the tendon, and noticing the flexion of the toes in the case of the long flexor. The tibialis posticus lies anterior, and the flexor longus digitorum next, the posterior tibial artery and the nerves are posterior. There are also two small plantar cutaneous nerves.

Fig. 155.—Dr. Davis' wire foot stretcher applied to the patient in Dr. Bradford's position, for manipulation of the foot.

In cases in which the varus is extreme and due to position rather than to muscle pull, especially when the muscles are weak, after correcting the deformity by manipulation and tenotomies, silk ligaments may be used for one or two years to maintain stability of the ankle. In children over seven or eight years old, and in adults where the ankle is very much relaxed (the so-called "dangle foot") an astragalectomy with displacement of the foot backward is advisable. This will give good lateral stability without a stiff joint. Where silk liga-

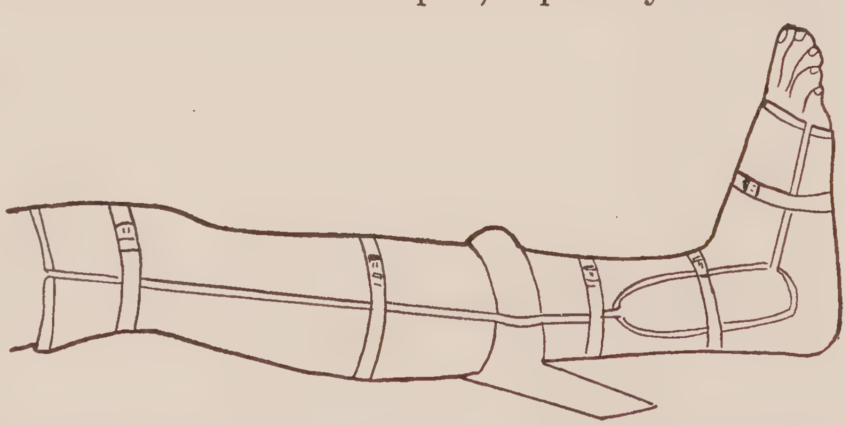

Fig. 156.—Plaster split at the sides with plaster rope flattened to prevent rotation of the leg. Side view.

ments are used as a temporary means of retaining the foot, Dr. Bradford's operation for subcutaneous silk ligament is simple (see section 173) and preferable to the method by open incision.

An open or closed operation, cutting all resistant tissues on the inner side of the foot called the Phelps operation, should not be done. There are much better and less mutilating operations to correct varus or equino varus.

105. Operation on the bone for Extreme Varus, or Equino Varus (club foot operation) Congenital or Acquired.—The following operations are

FIG. 157.—End view of figure 156.

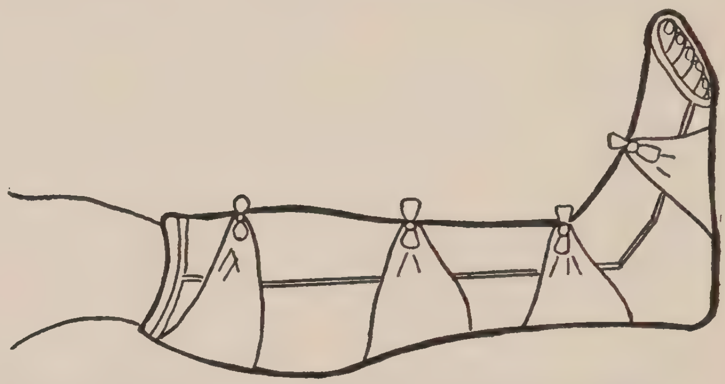

FIG. 158.—Method of spreading a wet three inch gauze bandage and tying a split plaster.

indicated in congenital club foot as well as in the infantile and acquired forms, depending on the degree of deformity. When it is extreme, it

FIG. 159.—Equinus.

FIG. 160.—Equino varus. Club foot. Plantar view.

FIG. 161.—Equino varus. Club foot. Lateral view.

is often necessary to take a small wedge from the forward end of the os-calcis and sometimes from the astragalus to obtain complete over-correction of the deformity.

In the paralytic club foot it is not necessary to overcorrect to the same extent that it is necessary in the congenital, but a slight over-correction should always be made. If the deformity is extreme, however, the over-correction should be proportionate.

When after manipulation and tenotomy of the plantar fascia a complete over-correction is not obtained, without force, a small wedge of bone is removed from the astragalus and os-calcis (see shaded portion, figure 163). This is done through an incision anterior to the tip of the fibula and extending towards the prominence at the base of the fifth metatarsal. The incision is carried down to the bone, the tendons and muscles

retracted, exposing the prominent portion of the astragalus. A small wedge is removed from this bone in such a way that the closing of the gap will allow the foot to dorsally flex. The osteotome should enter the bone some distance from the tibia in order that the callus from bone healing will not interfere with the motion of the ankle joint. See figure 494. Should the eversion be difficult to obtain, a small wedge is taken out of the forward end of the os-calcis, allowing the foot to evert. A

Fig. 162.—Calcaneous.

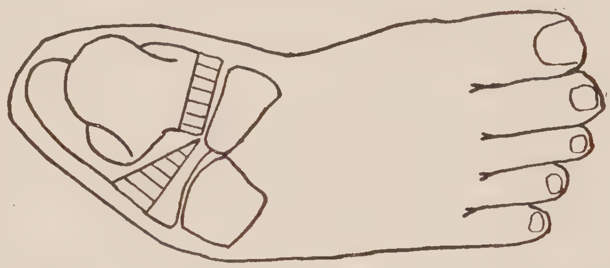

Fig. 163.—Shaded portion of bone must sometimes be removed in extreme club foot deformity. The size of the wedge and its shape will vary with the deformity.

small wedge of bone should be removed and then more as the case requires, though an operator familiar with bone operations for club foot may often judge the right amount from the start. Where much tilting of the os-calcis accompanies an equino varus, Dr. Ober has suggested the loosening of the ligaments from the internal malleolus allowing the overcorrection of the tilt of the os-calcis during the correction of the deform-

Fig. 164.—Incision two inches above the tip of the malleolus curving downward and forward.

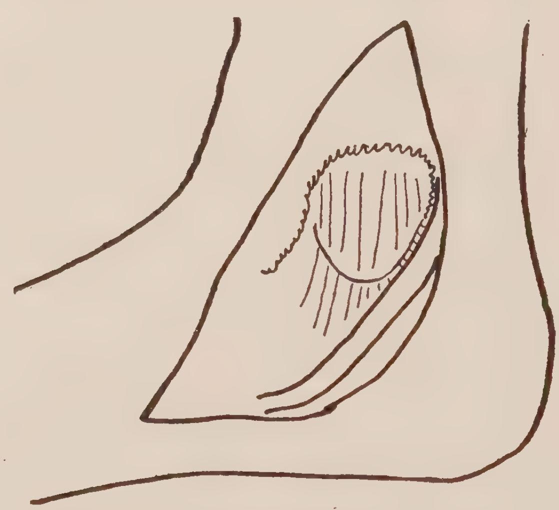

Fig. 165.—The regular line marks the malleolus, the irregular line indicates the raised periosteum. The tendon is below.

ity at the front of the foot. This latter operation is often sufficient without removing bone.

106. Operation for Equino Varus, Congenital or Acquired. Relieving the Internal Ligamentous Attachments when the Os-calcis is Tilted or Rotated in and under. Dr. Ober's Operation.—The foot is prepared in the usual way, the patient lies on his back, a sand bag is placed under the foot, the operator stands on the outer side of the right foot,

an assistant holds the ball of the foot while the incision is being made.

Before making an incision, the foot is manipulated and stretched as described under Manipulation. An incision is made on the inner side of the tibia from a point 1½ to 2 inches above the internal malleolus, curving downward and forward to the scaphoid (see figure 164). The incision is curved slightly; it is carried down to the bone, its edges retracted exposing the periosteum over the internal malleolus (see figure 165). This periosteum is incised across one inch above its tip, and on either side of the tip, the periosteum is raised in one piece from the flat surface of the bone, the irregular line marks the raised periosteum (figure 166), the anterior and posterior surfaces continuously with the

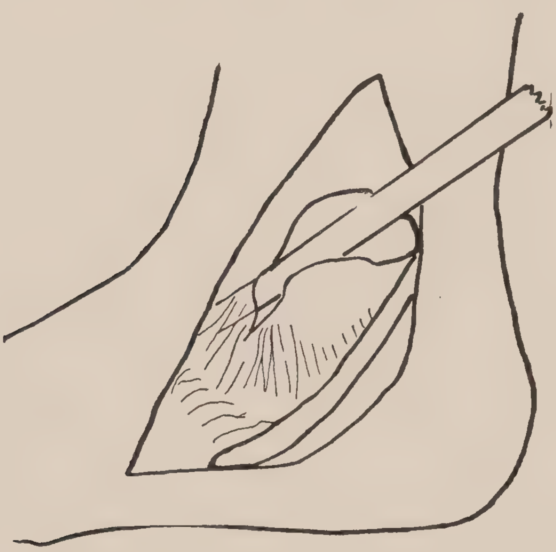

FIG. 166.—The osteotome raises the periosteum and ligaments subperiostially extending anteriorly.

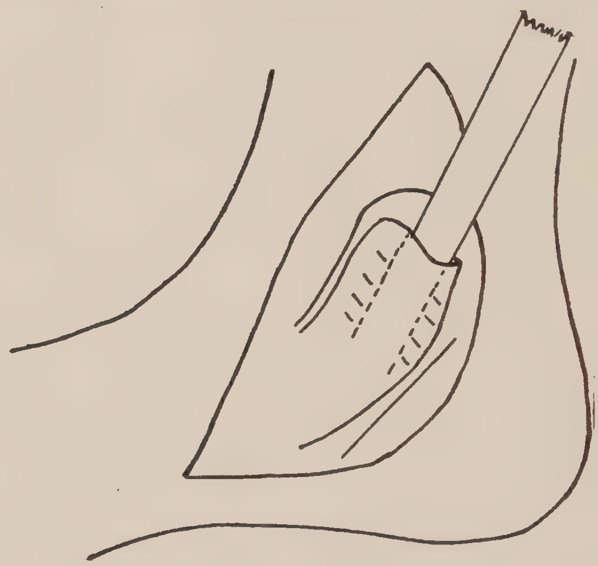

FIG. 167.—The osteotome raises the periosteum and ligaments subperiosteally below the malleolus.

ligaments, and on either side of the malleolus (see figures 167 to 170). An osteotome is used to lift the attachment of the ligaments free from the malleolus continuously with the periosteum. The lifting of the periosteum and ligaments is continued to the ligaments of the astragalus and os-calcis, the astragalus and scaphoid allowing the foot to swing freely outward. The raised periosteum on the tibia is drawn downward as the deformity is corrected. The internal lateral ligament is freed together with the anterior ligament, the dorsal astragaloscaphoid ligament, and the attachment at the scaphoid tubercle. The foot is then manipulated and the amount of overcorrection estimated. It is sufficient if the tilt in the os-calcis is overcorrected and the cuboid goes well up into place, and if the dorsal motion to the foot and eversion of the front part of the foot is easy to obtain. The tendo Achilles is tenotomized last (see previous chapter on Tenotomy of the Tendo Achilles). This tenotomy is done last as it is necessary for it to hold the os-calcis during the correction of the deformity. If sufficient correction is not obtained by freeing the ligaments the operator will use the Thomas

wrench (see figure 124), or the Bradford wrench (see figures 135 and 145) before and after cutting the tendo Achilles; the periosteum is not sutured. The deep tissues are brought together over the bone by interrupted chromic catgut sutures number 00, the subcutaneous tissues with interrupted chromic catgut sutures number 00, and the skin with continuous chromic catgut sutures number 00. A very small amount of gauze is placed over the wound, only about four thin layers, extending one-half inch either side and beyond the ends of the incision in order to have no lumps. Sterile sheet wadding is next applied to fit the foot snugly so that the outlines of the leg and foot are shapely and the amount of correction easily estimated. A plaster of Paris bandage is applied from the toes to the groin with the knee bent. (For details of this plaster, see below.)

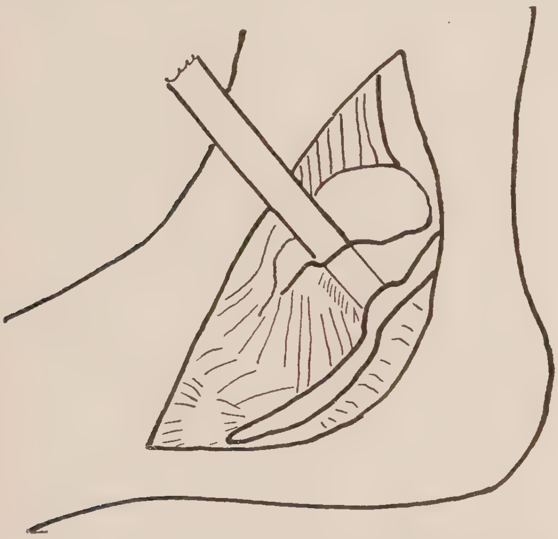

FIG. 168.—The osteotome extending backward subperiosteally under the ligaments and tendons.

FIG. 169.—Lateral view. The irregular line indicates the tissues raised subperiosteally from the tarsus.

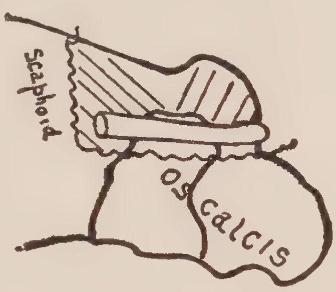

FIG. 170.—Plantar view. The irregular line indicates the tissues raised subperiosteally from the tarsus.

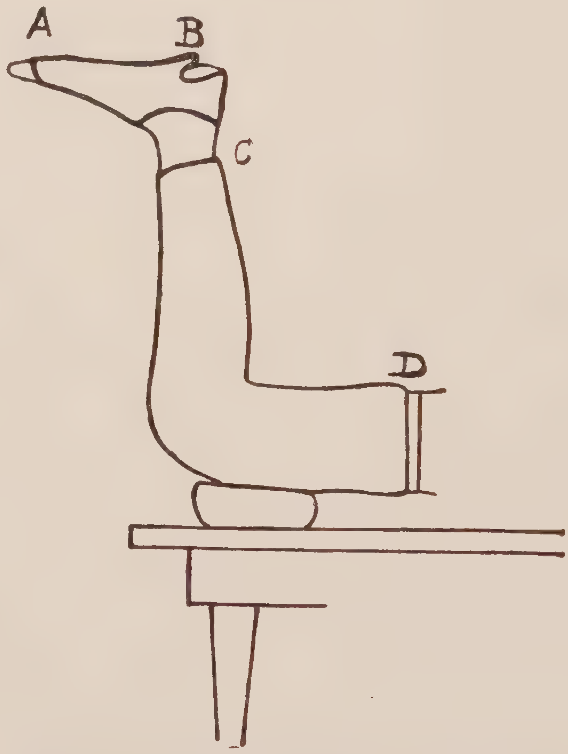

FIG. 171.—Club foot plaster. AB, Solid foot cuff of the plaster bandage with only two heel turns to hold it on. CD, Leg and thigh cuff. When these cuffs have hardened the foot is held over-corrected, the plaster then is completed by uniting the two cuffs.

It will be noticed in this operation that the operator raises the periosteum from the inner side of the internal malleolus, a strip 1 or 1½ inches long, 2 inches in adults and as broad as the malleolus. As this is raised from the bone with an osteotome, it is lifted continuously with

the ligaments and periosteum below for at least an inch below the tip of the malleolus. The periosteum anteriorly is raised from the tip of the malleolus continuously with the ligaments and periosteum over the bones for at least an inch forward and downward. Posteriorly the same process is repeated, the osteotome dipping behind the tendon sheath and lifting them with the periosteum below them (see figures 169, 170).

107. Application of Plaster for Varus or Equino Varus, Club Foot Plaster.—Some care is necessary in applying a plaster to the foot for correction of bone deformity; a liberal amount of well fitting sheet wadding is applied then. About eight layers of plaster of Paris bandage are applied around the ball of the foot and metatarsals, two layers only around the heel to prevent this cuff from slipping off. This is allowed to harden while the plaster is applied to the thigh and leg with the knee flexed eighty degrees. When these two portions are hard, the patient is turned over on his abdomen and a pillow is placed under the knee. The operator holds the foot overcorrected (see figure 171), while an assistant joins the two portions of the plaster, In this way there is no cramping of the toes which are held flat and the plaster is applied to the deformity while it is held corrected. If the operation has been thoroughly done, the foot will easily overcorrect without force. Good overcorrection of the deformity is a sure method of preventing pressure sores and discomfort from the plaster. The position of overcorrection of the foot in plaster is important. A vertical line through the middle of the lower leg is drawn on the plaster. This line should be determined by an imaginary plane passed through the femur and tibia. The foot should be abducted fifty degrees from this plane. It should be dorsally flexed about twenty-five degrees, the cuboid being raised more than the rest of the foot (see figure 172).

Fig. 172. — After operation a club foot should be held in plaster well abducted dorsally flexed and with the cuboid elevated.

108. The After Treatment of Equino Varus.—The patient should wear a plaster for six or eight weeks with the knee flexed forty-five degrees to eighty degrees and maintaining extreme overcorrection (see figure 172). At the end of this time a lighter plaster is applied with the knee flexed only twenty degrees. The patient is allowed to walk on the plaster. Wooden, felt or plaster wedges are applied to the sole of the plaster to aid in locomotion. When walking is good, a wedged shoe (see figure 173) and brace, or simply the wedged shoe is worn. Exercises for all the muscles become part of

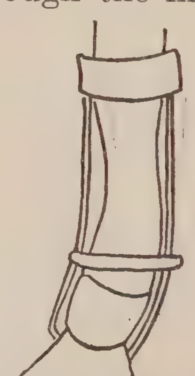

Fig. 173.—Wedged shoe. When an overcorrected position is to be maintained, the brace is bent, the heel of the shoe is broadened and wedged to make walking more easy.

the after treatment with manual overstretching of the deformity daily.

109. Methods of Obtaining Stability at the Ankle and Foot. Operation for Valgus, Equino Valgus and Calcaneo Valgus. Flat foot.— The following operation is also used for congenital and acquired flat foot.

Equino valgus, calcaneo valgus and flat foot, valgus (figures 175, 176).

In some paralytic and congenital valgus deformities the tibialis anticus and tibialis posticus, and long flexors of the toes are either paralyzed or very much weakened, or proportionally weaker than their opponents. In some cases the muscles are all weak and the deformity is due to attitude or bony growth. In these conditions the peronei muscles are sometimes found very strongly contracted, so that they seem powerless. To restore a balance of the foot, first the deformities should be overcorrected by operation unless they are very slight and the muscles trained and given the best possible chance to develop under orthopedic treatment. In paralytic cases where the peronei are strong and the patient cannot raise the foot, a transplantation of the peronei forward is often advisable. When this is decided upon the muscles are transplanted as described elsewhere under muscle transplantation. The position of insertion of the tendon will depend on the position and strength of the other good muscles. In extreme valgus the internal cuneiform, or scaphoid, may be selected as the best position for insertion; in some other deformities the middle or outer cuneiform. Where there is good lateral stability at the ankle, the tendon should be put in about the middle of the foot. Where there is a marked lack of stability at the ankle joint an astragalectomy with displacement of the foot backward gives an extremely good foot without stiffening the ankle and to this a transplantation of the peronei forward may be done to great advantage. Where the extensors of the toes are extremely active, and this is often the case in paralytic cases where the peronei are spared, there is often a marked hammer toe due to the contracture of the extensors of the toes which are stretched upward as they are constantly used in raising the foot. Where there is a hammer toe, it is well in the case of the great toe to transplant the tendon of the great toe into the head of the metatarsal, and also to use the other long extensor of the toes either in the same way, or better still to attach them to the tarsus and cut them away below.

Fig. 174. — Valgus with hammer toes.

110. Extreme Valgus, Calcaneo Valgus, and Equino Valgus.—If there are no muscles to transplant any one of the above methods of correction may be selected. For a very hopeless flail ankle an astragalectomy and displacement of the foot backward is the operation of choice. When it is possible to transplant a muscle to a

position of greater usefulness it should be done in addition to correcting the valgus.

When a valgus has existed for a long time uncorrected and there is often much bony change similar to that seen in congenital valgus cases, a wedge of bone may be removed from the scaphoid and adjoining bones further outward, the closing of the gap correcting the abducted and flattened foot. When the os-calcis tilts markedly, the external ligaments may be loosened subperiostically from the external malleolus, and from the os-calcis subperiosteally as described below, allowing the bone to swing under the astragalus and tibia.

Fig. 175. — Valgus, plantar view.

The correction of valgus is usually possible by manipulation with the hands or by one of the wrenches described for manipulation of the foot. The foot should be made limber in all normal directions and the valgus overcome.

When the condition is extreme, and has existed since the onset of a paralysis, the correction should be made by operation and the tibial muscles allowed to regain strength. When this does not occur or if they are found to be definitely paralyzed or extremely weak, after attempts to train and develop them, a transplantation of other muscles forward may be made. The correction of valgus due to deformity of the bone is best done by removing a wedge from the scaphoid, or if the ankle is flail, by an astragalectomy, or both tibialis tendons may be inserted into grooves in the tibia anteriorly and posteriorly and buried there to act as internal ligaments preventing valgus (see Artificial Ligaments).

111. Bone Operation for Valgus or Equino Valgus or Calcaneo Valgus.—The patient lies on his back, the knee outwardly rotated, a rubber bandage is applied to evasculate the foot and leg and a tourniquet is applied below the knee, the foot resting on a sand bag. The operator stands on the side of the leg to be operated on.

Fig. 176. — Valgus, lateral view.

An incision is made one-half inch anterior and one-half inch below the internal malleolus extending forward to the first metatarsal. The incision is carried down to the bone, the tissues dissected up, retracted in one layer exposing the scaphoid; the tibialis tendons are retracted and carefully protected from injury. A wedge of bone is removed from the scaphoid and the adjoining bones, if necessary, to allow the foot to swing in, as the gap closes. The periosteum is tough at the inner side of the foot, making it easy to place sutures to hold the bones together. The deep and superficial tissues are brought together with interrupted chromic catgut sutures number 00, the skin with continuous chromic catgut sutures number 00.

If the deformity is largely due to a tilted os-calcis, the following operation will be useful.

112. Operation for Valgus with Marked Tilting of the Os-calcis.—The patient lies on his back, the operator stands on the side of the leg to be operated on, a rubber bandage and tourniquet are applied.

A curved incision, two and one-half inches long is made one inch above the tip of the external malleolus, extending forward and downward to the cuboid. The skin and subcutaneous tissues are dissected up exposing the malleolus. An osteotome is used to free its ligaments subperiosteally from the outer, inner, posterior and anterior surface, also the attachments of these ligaments to the os-calcis and astragalus; all are freed subperiosteally. This will usually allow the foot and os-calcis to be brought into position either manually or by wrenches. If not the astragalo calcaneous ligament is separated subperiosteally by means of an osteotome inserted between these bones. The attachment here is very extensive, the separation should be done with care in order to cut all the fibers, the operator feeling for each soft attachment and cutting it, injuring the bone as little as possible. The foot wrenches (figures 123 to 155) will aid the operator to complete the overcorrection. If sufficient overcorrection cannot be obtained by this process, the operator should remove a wedge of bone as described for valgus.

113. Plaster of Paris Bandage for Valgus.—A plaster of Paris bandage is applied from the toes to the groin with the knee bent, as follows: a liberal quantity of well fitting sheet wadding is applied to the foot and leg, an extra amount being placed on the heel. Eight turns of plaster bandage are placed over the ball of the foot and around the metatarsals in front. Only one or two turns are made around the heel to hold the cuff on. The cuff is allowed to harden while the plaster is put on from above the ankle to the groin with the knee bent. When this has hardened the patient is turned over on his abdomen, the knee rests on a cushion, the operator holds the ball of the foot in a dorsal position and adducts it, correcting the deformity while the plaster is completed between the foot cuff and the leg. The heel should not be allowed to be dented or to rest on the table or bed. After an extensive operation, the patient is kept quiet for three weeks. After that he is allowed to sit in a chair. At the end of the fourth week he walks on the other foot, using crutches. Weight-bearing is allowed in the eighth week, depending on the case; always with the plaster at first. After the eighth week the knee may be flexed twenty degrees only.

In infantile paralysis, as in congenital valgus, overcorrection is made with the feet in marked adduction so that they interfere in walking. This is maintained at least six months. Walking is made possible by wooden or plaster wedges under the sole of the plaster.

When a transplantation is done at the same time, the rules laid down for transplantation must be observed; when tenotomies alone, or mechanical wrenching, these conditions will govern the after treatment.

Rules for after treatment in these cases are laid down under transplantation, tenotomy, use of foot wrenches, etc.

This arrangement of the plaster is important in most operations on the foot. A window is cut in the plaster over the point of operation to allow inspection of the incision. The plaster should be split on both sides so that it may be loosened or removed. The patient is allowed to walk on the foot at the end of six weeks with the plaster on. When the patient is able to walk easily with the plaster it may be removed for a few steps two or three times a day until walking is easy without the plaster. When this has been accomplished the plaster is omitted. The leg and foot should be exercised and the muscles trained.

114. Operation for Arthrodesis of the Astragalo-scaphoid Joint, for Valgus Foot Strain and Partial Paralysis.—This operation is done for weakness or partial paralysis of the plantar muscles. Sometimes when one or both tibials are weak, allowing the foot to sag and causing a strain at this joint, there is often an intermittent pain.

The patient lies on his back. For operation on the right foot, a pillow is placed under the right knee, flexing it to about thirty degrees, the operator stands on the same side as the foot to be operated on. A sand bag is placed under the ankle and foot.

An incision is made one-half inch forward and one-half inch below the internal malleolus, two inches long, extending forward almost to the head of the first metatarsal. The incision is carried down to the bone. The anterior tibial and posterior tendons are avoided and retracted. A small osteotome is used to remove the cartilage from the forward end of the astragalus and from the adjoining scaphoid. The denuded bony surfaces are made to fit smoothly and the foot is adducted, forcing the bones together. The position of the foot in the plaster will hold the bones together. The bones may be drilled and a kangaroo, or double chromic catgut suture, used to fasten the bones into firm apposition.

The deep tissues are brought together with interrupted catgut sutures number 00, the skin with continuous chromic catgut sutures number 00. The foot would be put up in a good position for weight-bearing plus a slight overcorrection in adduction and in about twenty-five degrees of dorsal flexion. The position should be one useful in walking. A plaster of Paris bandage is applied from the toes to the middle of the thigh with the knee slightly bent. It is important that the knee should be bent in order that the plaster will not rotate on the leg.

115. Operation for Talipes Calcaneous.—Where the tibialis anticus is very strong and there is a calcaneous deformity, due to complete paralysis of the muscles to the tendo Achilles one of the peronei muscles or the toe flexors, or posterior tibial, may be transplanted backward to the tendo Achilles. The muscle selected will depend on the deformity. If there is a tendency to valgus with the calcaneous (see figure 159), one of the outer muscles should be used; if there is a tendency to varus one of the inner tendons should be used. In some cases the tibialis an-

ticus or the long toe extensors or both must be put to the middle or slightly to the outer side of the middle of the tarsus in order to make up for the muscle transplanted backward. Very often an astragalectomy is necessary with or without transplantation of muscles. Tendon fixation of the tendo Achilles as described by Dr. Galli may be used. Shortening of the tendo Achilles is not to be recommended. Dr. Galli's tendon fixation gives added life to the paralyzed tendon from the cortex of the bone. Shortening a paralyzed tendo Achilles is of temporary value only, for it will stretch again.

Operation for Astragalectomy and Displacement of the Foot Backward (see under Flail Ankle) section 168.

Operation for Silk Ligaments at the Ankle (see under Flail Ankle) section 171.

Operation for Tendon Fixation at the Ankle (see under Flail Ankle) section 174.

Operation for Arthrodesis at the Ankle (see under Flail Ankle) section 199.

116. Operation for Pes Cavus.—The pain in pes cavus is most frequently due to the flexed position of the toes, lack of upward motion of the foot and lack of spring due to the contracture. The toes may be corrected by an operation on the tendon, and sometimes on the bone of the phalanges, as described in these pages (see Hammer Toe). Painful calluses under the ball of the foot are due to the position of the toes and foot. The foot deformity cannot always be relieved by wrenching and tenotomy of the tendo Achilles and plantar fascia. In extreme cases there is little or no upward motion of the foot. It is necessary to remove a small wedge from the astragalus allowing the normal upward motion of the foot (see figure 177). When sufficient overcorrection is obtained in this manner a tenotomy of the plantar fascia should be done.

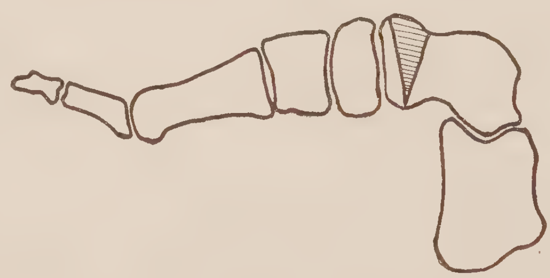

FIG. 177.—Pes cavus; shaded lines indicate wedge removed from the astragalus, to allow upward motion of the foot.

When the pes cavus is due to paralysis and the other leg is not paralyzed the deformity gives length to the leg and should not be interfered with when there is no pain.

PES CAVUS OPERATION ON THE BONE

MR. JONES' OPERATION

(A) Calcaneo-cavus where the calf paralysis is complete.

The operation is to be done in two stages, four weeks intervening.

Stage I. Divide the plantar fascia if contracted, and wrench with hand or instrument. Make an incision down to bone about three inches in length on the inner side of the foot; the centre of the incision being

opposite the angle of convexity. With periosteum elevator, separate the soft structures from the tarsus above and below from the inner to the outer side. Remove a transtarsal V-shaped section of bone (see figure 178). If there be valgoid deformity let the section be wider on the inner than on the outer side. Suture, and obliterate the cavus deformity by extending the foot which is not bandaged to the tibia, the calcaneous deformity being apparently much increased (see figure 179). More sheet wadding is applied to the leg and foot and a plaster of Paris bandage from the toes to the knee holds the foot in thirty degrees flexion. It is often necessary to use a piece of saddle felt under the ball of the foot in addition to the sheet wadding as pressure here is often painful. The hammer toe should be corrected at the same time (see Hammer Toe Operation). The plaster should be split on both sides so that the front can be removed and the incision inspected. This plaster is worn for

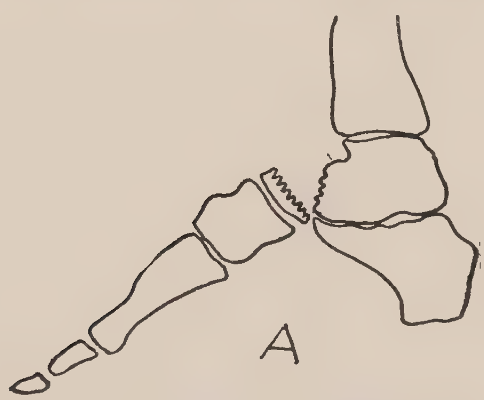

FIG. 178.—Wedge removed (after Mr. Jones).

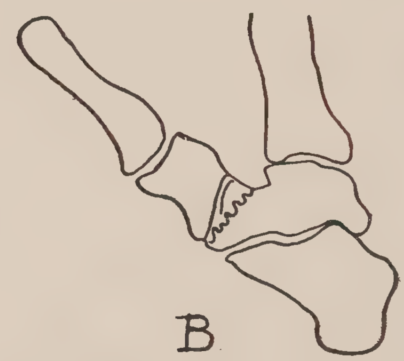

FIG. 179.—Closing the gap after removing the wedge.

four weeks. After that time the plaster is rapidly removed as the patient acquires strength in walking.

Four weeks after the wedge of bone has been removed from the astragalus, Mr. Robert Jones has suggested removing a wedge from the os-calcis to completely correct the cavus (see figures 178 to 181).

Stage II (four weeks later).

Make a longitudinal incision at back of heel, the centre being opposite the ankle-joint. Open the joint and take a wedge from the astragalus, sufficiently large to be accurately obliterated when the foot is brought to right angles. Denude tibia and fibula of cartilage (see figure 180). The foot should be brought to right angles and fixed immovably until union is complete (see figure 181).

(B) Calcaneo-cavus where some power remains in the calf muscle.

Stage I as before.

Stage II. Shorten the capsule. Shorten the tendo Achilles, remove a skin flap and after three weeks, massage the gastrocnemius. In this case it is not advisable to remove bone. In older subjects it may be necessary when removing a wedge to incise the outside as well as the inside of the foot. For some weeks after walking has commenced the foot should be protected against strain.

In cases where the leg is shorter than its fellow, it is often undesirable to do the operation on the os-calcis, if the tendo Achilles has sufficient tension. The vertical position of the os-calcis increases the length of the leg and no pain is usually experienced after the correction of the astragalus which allows normal dorsal motion of the foot. It is always important to correct the flexion of the toes at the metatarso phalangeal joints so that these bones may be flexed seventy-five degrees with ease. The hammer toe should also be corrected (see Operation for Hammer Toe), section 118. Six weeks after the bone operation the patient is allowed to bear weight on the feet with the plaster twice daily, ten to twenty steps. This is increased as the case allows, every two or three days. After two weeks most patients can walk short distances about the house with the plaster. When walking is sufficiently good, the

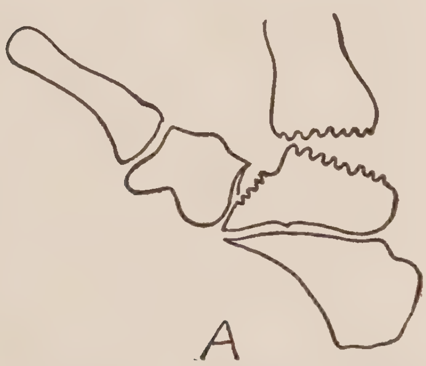

Fig. 180.—Mr. Jones' operation. Stage II (after Mr. Jones). Wedge removed.

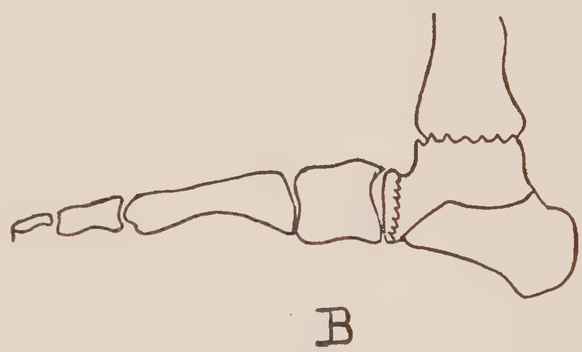

Fig. 181.—Bone brought together after removing the wedge.

patient is allowed to walk without the plaster a little at a time. Four months after the operation he walks without supports.

117. Deformities Limiting the Motion of the Ankle Joint Following Potts Fracture.—When the deformity is in the tibia and fibula a subcutaneous osteotomy may be done through the tibia and fibula allowing correction of the deformity. A small incision is made over the deformity in the lower third of the fibula and the lower third of the tibia. These bones are cut through with an osteotome and the deformity corrected.

The foot should be manipulated with or without a wrench as the case requires so that complete dorsal motion, adduction and abduction of the foot is allowed. The foot should be put up with thirty degrees dorsal flexion, the plaster extending from the toes to the groin, the knee slightly flexed. At the end of three weeks, the patient is allowed to walk with crutches and a straight plaster is applied. In the fifth week he begins to bear weight on the leg with the plaster.

When the alinement of the tibia and fibula is good, the astragalus will sometimes infringe on the tibia limiting the motion of the foot. To correct this, a wedge of bone is removed from the astragulus sufficiently

large to allow thirty degrees of dorsal motion of the foot. A foot stretcher will be found of service in relieving the contractures of the soft tissues that contribute to the deformity.

118. Hammer Toe Operation. Clawfoot (see figures 182 to 187).—Sometimes this condition can be corrected by stretching the toes; when this is sufficient an operation is unnecessary. To correct a more extensive deformity it is usually necessary to tenotomize or lengthen the extensor longus digitorum, tenotomize the toe flexors and sometimes do a tenotomy of the metatarso phalangeal capsule and relieve the capsular shortening of the joints beyond the metatarsal. Besides this a small piece of bone must often be removed from the proximal end of the phalanges.

Fig. 182.—Hammer toe. Claw foot.

Sometimes a tenotomy and stretching of the toe is sufficient. When the tenotomies have been done if the toe readily adopts its deformed position the correction will not be satisfactory without operation on the bone. It is of course possible to stretch and tear the joint until it straightens out, but this adds injury, with resulting swelling and pain, making it difficult to maintain overcorrection. It is simpler to incise, remove a small piece of bone without stretching and tearing, without roughness, and obtain complete overcorrection with almost no swelling if the operator handles the toe gently. The result is more satisfactory to both patient and operator. When the case is of long standing, it is better to resort to the bone operation from the first, then do what tenotomies are necessary without extensive manipulation. For the different methods of tenotomy of the tendons involved, the reader is referred below. The removal of bone as described below is by far the simplest way to correct an extreme hammer toe. The adjustment of the shortened tissues is immediate and without cutting them. The operator must never overlook the deformity of the joint above and below the main deformity.

Fig. 183.—Skeleton of claw foot.

Fig. 184. — Subluxated phalanx. A deformity accompanying claw foot or hammer toe.

Fig. 185. — Incision for reaching the phalangeal bones or joints.

Fig. 186.—Shaded line indicates bone removal.

Fig. 187.—Shaded line indicates joint removal.

119. Hammer Toe and Clawfoot. Contracted Extensor Longus Digitorum and Hammer Toe Deformity (see figures 182 to 187).—When a hammer toe is of long standing, an operation is usually done to relieve the contracted tendon which extends the phalanx on the metatarsal. When the cause of extension of the phalanx is due to the constant use of the extensor of the toe to raise the foot in walking, it is advisable to insert these tendons, either into the tarsus higher up or into the head of the metatarsal bones and completely separate the tendons below from the toe.

120. Hammer Toe and Clawfoot. Subcutaneous Tenotomy of Extensor Longus Digitorum near the Head of the Metatarsal.—Where the extensor contraction is very slight but needs operation, a subcutaneous tenotomy of the extensors of the toes may be done as shown in figure 188. The operator feels for the tendon with the finger of the right hand, enters the skin vertically, to one side of the tendon, lifts the skin with the side or the dull edge of the tenotome, and slides it under the skin over the tendon. The blade is inserted on the side of the tendon beyond. The operator puts the tendon on a stretch by flexing the toe and the tendon is cut across with a gentle sawing motion. The cutting of the tendon gives the same sensation as the cutting of celery. When the tendon is completely cut across there is a snap and the toe will be relaxed.

Fig. 188.—Subcutaneous tenotomy of the toe extensor.

When there is very slight hammer toe and no change in the capsule, the operation may be done with ethyl chloride anæsthesia.

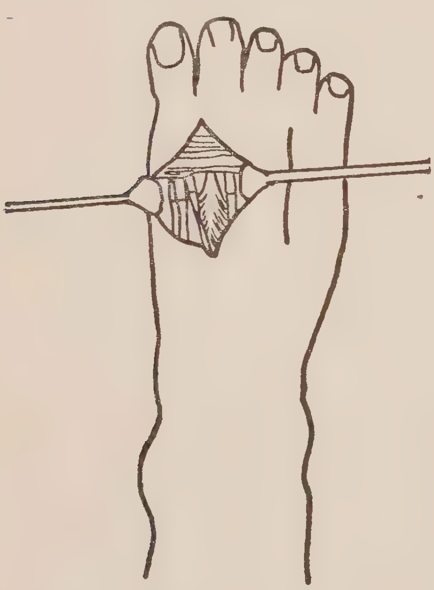

Fig. 189.—Open operation for tenotomy of the contracted long toe extensors.

121. Hammer Toe and Clawfoot. Tenotomy of the Extensor Longus Pollicis near the Head of the Metatarsal. Open Tenotomy.—Two longitudinal incisions are made (see figures 189, 305), one over and parallel to the second metatarsal, and the other over and parallel to the fourth metatarsal; through these incisions by retracting to one side and then to the other all the tendons are easily reached and tenotomized without injuring other tissues. Tenotomies of the capsules are usually necessary and manipulation and stretching of the toe at each joint.

122. Hammer Toe and Clawfoot. Operation for Tenotomy or Tendon Lengthening the Extensor Longus Digitorum Tendons in the Leg.—The patient lies on his back, the operator stands on the side of the leg to be operated on

An incision is made two inches long over the front and lower third of the leg through the skin and fat. The skin and subcutaneous fat are retracted and the anterior tendons are exposed. Lifting each tendon on a blunt instrument will give sufficient pull to show to which toe it extends. Each extensor tendon may be cut with a tenotome halfway through on one side and halfway through on the other at a different level, pulled down and sutured as described elsewhere for tenotomy of the tendo Achilles (see figures 216 to 217), or one of the other methods of tendon lengthening should be used, described elsewhere in these pages under tendon lengthening (section 127)

After a simple tenotomy, the foot is put up in a plaster of Paris bandage in an equinus position for about a week, then brought up to right angles. The patient is then allowed to walk with the plaster after the third week. After that the plaster may be removed part of each day and rapidly discarded.

After a tendon lengthening the patient should not walk on the foot for seven or eight weeks. At first he walks a little with the plaster on. The length of time is gradually increased and the plaster omitted a little each day until walking has become easy. This operation will rarely be needed, for where the extensor tendons have become excessively strong and consequently short, it is better to put them into the tarsus and use them to raise the foot rather than to lengthen them.

123. Hammer Toe and Clawfoot. Operation on the Bone (see figures 185, 187).—An incision three-fourths of an inch long is made to the inner or outer side of the dorsal tendon down to the bone. The incision through the skin and fat should be made in one layer in order to keep the flaps as thick as possible. If the toe shows pressure from the shoe more on one side than the other, the side showing the least pressure should be chosen for the incision. The incision is made as shown in figure 185. It is carried down to the bone, the periosteum of the proximal end of the phalanx cut through and then lifted by means of a small sharp osteotome. The tissues must be freed subperiosteally before the bone can be removed. This subperiosteal dissection is made with a small sharp osteotome which minimizes the injury to all the soft parts. A small portion of this bone is removed enough to allow the joint to be overcorrected without force (see shaded portion of figure 186). The joint should be perfectly loose and able to flex or extend after removing the bone. At the time of the operation, it is almost always necessary to relieve the extended position of the joint above the one flexed and

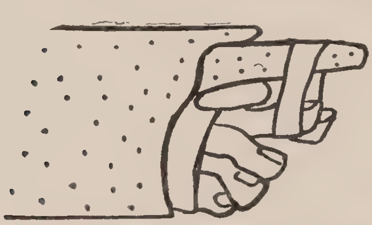

Fig. 190.—Plaster digit for maintaining correction after operations on the toes or fingers.

often a tenotomy of the extensor tendons, or capsule of the joint above, is necessary. When the tenotomies are necessary besides the bone operation the reader is referred to the description of tenotomy of these tendons. If the operator chooses to excise the joint instead of removing the bone from the proximal end of the second phalanx alone, he operates as follows.

Fig 191.—Splints for holding the toes, sheet wadding cuff and bandage over ankle and foot.

Fig. 192. — Splints for holding the toes. Multiple bent copper wire rectangles applied to ankle cuff and foot cuff and held by adhesive bands.

124 Hammer Toe Operation and Claw-foot. Joint Excision.—An incision is made as in the previous operation (see figure 187), down to the bone (the incision need not be more than three-fourths of an inch long). The periosteum is incised by means of a small sharp osteotome; it is raised and an excision of the joint performed by subperiosteally cutting the distal end of the proximal phalanx and the proximal end of the second phalanx. Enough bone is removed to allow very free extension and flexion of the joint. It is usually necessary, in a hammer toe operation, to do a tenotomy of the extensor of the joint just above, and sometimes of the capsule of that joint to allow easy flexion at that point (see Operation on Extensor Tendons of the Toes, section 154). The subcutaneous tissues may be brought together with interrupted chromic catgut sutures number 00 and the skin with continuous chromic catgut sutures number 00. A wire splint (see figures 191 to 194) with adhesive or a wooden plantar splint, well padded, is applied to the whole foot and toes operated on and a plaster of Paris bandage over this, a special plaster rope or finger is applied beyond each toe (see figure 190). When the operator has handled the toe gently there is practically no swelling after five days. The patient should be taught to passively hyperextend and stretch the toes where they were flexed and to flex the metacarpo phalangeal joints which were extended. This is done five to ten times, four times a day. The patient walks with the plaster in two weeks. The toe should be given freedom in a moccasin after that for two or three weeks, then a very broad shoe used. The stretching exercises are kept up by the patient twice daily for eight weeks. The treatment must vary for the individual case.

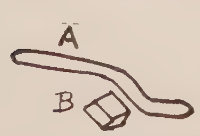

Fig. 193.—Post operative hammer toe splint. A, Represents copper wire rectangle bent to hyperextend the toe. B, Felt pad used in hyperextending the toe.

Callouses under the ball of the foot are usually due to a contracted condition of the overlying joint which nature protects by callouses. To overcome a callous which is often painful it is necessary to overcome the extension of the toe and flexion of the phalanx or both as the case may be. When the deformities are overcome, the callous may be treated and will gradually disappear.

125. Operation for Hallux Valgus.—Hallux Valgus often accompanies other deformities. Where the hallux valgus deformity is not extreme, a tenotomy, preferably a zigzag, of the extensor of the great toe may be done and an osteotomy performed through the base of the head of the metatarsal (see figures 195, 196).

A longitudinal incision is made one inch long to the inner side of the tendon of the great toe over the head of the metatarsal (figure 197). The incision is carried down to the bone, an osteotomy is performed through the head of the bone (figure 195), and the deformity overcorrected at the point of osteotomy.

An osteotomy requires a very small incision.

FIG. 194.—Adhesive bands holding wire and foot and ankle cuffs. Splints for holding the toes.

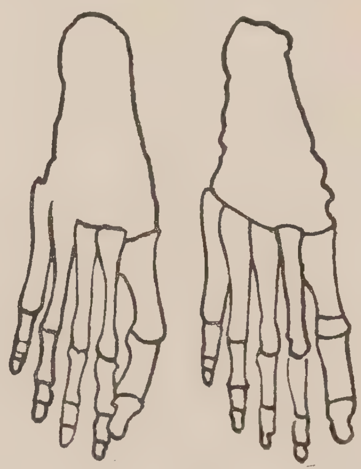

FIG. 195.—Osteotomy for hallux valgus.

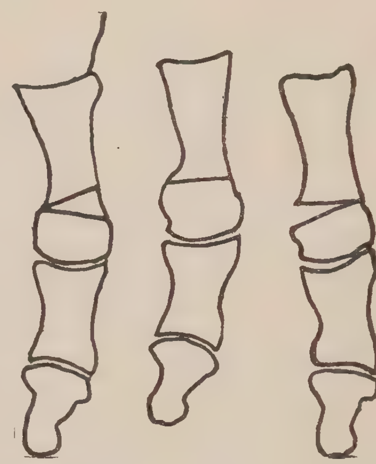

FIG. 196.—Wedge of bone removed for hallux valgus.

No dissection of the tissues from the bone is necessary, excepting immediately at the point of incision. This will give little swelling and good correction. It should be done close to the joint. The subcutaneous tissues are brought together with interrupted chromic catgut sutures number 00, the skin with continuous chromic catgut sutures number 00. A wooden plantar splint is applied (figure 198) to hold the toe in overcorrection. This splint should be made before the operation from a tracing of the foot (see figure 200). It is applied as shown in figure 199. A plaster is applied from the middle of the calf to the toe holding the foot at right angles over the splint. The plaster is split on either side so that the top may be removed and the dressing inspected without disturbing the position of the foot and toe. If one foot alone has been operated upon the patient may walk freely on the other foot as soon as the swelling has disappeared and the wound has entirely healed but not sooner than ten days. A child is kept in bed two weeks but he may

be allowed to sit up in bed. No walking on the foot should be allowed until the fifth week. The metatarsal head may be cut by a chain saw, applied around the head of the metatarsal by means of a special instrument devised by Dr. Osgood.

Sometimes a wedge of bone is removed to allow correction of the toe. For removing a wedge of bone the same incisions are used, a small wedge

Fig. 197.—Shaded portion of bone removed from the dorsal but not the plantar surface of the metatarsal for hallux valgus.

Fig. 198. — Post operative plantar wooden splint for hallux valgus, showing correction (see figure 200).

Fig. 199. — Plaster applied over plantar splint following hallux valgus operation.

of bone is cut with an osteotome from the base of the head of the metatarsal (see figure 196), or the bone may be removed from the upper and outer side of the head of the metatarsal (see figure 197), leaving the weight-bearing portion of the metatarsal on the plantar surface. This should never be removed. Most cases do well with almost any operation carefully done. The cases that do badly and are crippled afterward are those where the head of the bone has been removed or else the weight-bearing portion of the bone interfered with.

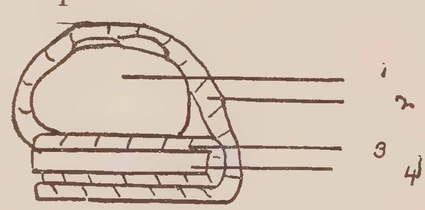

Fig. 200.—The striped lines outline the application of the adhesive to the splint to hold the toe adducted. Padding is put over the toe first.

Any small exostoses on the tip of the metatarsal may be removed with an osteotome. Patients with osteo-arthritis and those with infectious arthritis may get a stiff joint following this operation. It is to be avoided therefore in these cases.

CHAPTER II

MUSCLE AND TENDON OPERATIONS—MUSCLE AND TENDON TRANSPLANTATION

126. General Principles in Simple Tenotomies, Tendon Lengthening and Tendon Shortening.—A tenotomy is a simple way of relieving the tension due to a short tendon. Regeneration of a tendon is extremely good, especially the regeneration of certain tendons like that of the tendo Achilles. Subcutaneous tenotomy should not be performed where there are important blood vessels, or nerves, which might be accidentally cut during the operation. In tenotomizing a tendon it is important not to cut the whole of the sheath at the point of tenotomy. Experimentally it has been shown by Dr. Sever and others that regeneration of a tendon is favored by the presence of part of the tendon sheath. Where the sheath is entirely cut across, regeneration between the ends of the tendon is apt to be wholly by scar tissue. When some of the sheath remains, the tendon itself regenerates. A tenotomy is such a simple operation that when tenotomy of the tendo Achilles has been described there will be no need of describing the operation for other tendons.

Fig. 201.—Zig-zag tenotomy of the tendo Achilles. A good method.

127. Open Operation for Tendon Lengthening.—The skin and fat are incised and retracted exposing the tendon. A slit one-half inch long is made parallel to the tendon fibers vertically through its middle, and the slit connected with one at right angles at each end, one on the outside of the tendon at one end, the other on the inside of the tendon at the other end (see figures 201, 202). The ends are sutured or left free. The tendon may be slit diagonally from front to back, or diagonally from side to side with or without suture of its ends. The tendon sheath is closed loosely over the tendon. The subcutaneous fat and skin are brought together with interrupted chromic catgut sutures number 00.

Fig. 202. The tendon drawn out.

For conditions other than poliomyelitis and sometimes in poliomy-

elitis, if the deformity has been of long standing, or due to a fracture or dislocation, it must be remembered that there are probably other tissues maintaining the deformity beside the tendons. If these are bone, more extensive operations will be necessary. If the deformity is due to fibrinous adhesions or due to contractures of the soft tissues only, manipulation and stretching should accompany the tenotomy. The operator should have some form of foot stretcher on hand, such as the Thomas wrench or one of Dr. Bradford's club foot wrenches or Dr. Davis' foot stretcher.

FIG. 203.—X marks point for inserting tenotome.

In the case of spastic condition of the muscle, a tenotomy is often unnecessary to correct any equinus that is present. Should tenotomy of the tendo Achilles be done in spastic paralysis, the foot must be brought to a right angle position in from three to five days after operation. In cases of spastic paralysis in which a tenotomy has been performed, the foot is put up at first in five degrees or ten degrees of dorsal flexion rather than more. Spastic muscles at the ankle do not accommodate themselves readily to an over-stretched position. When the tendon to be lengthened overlies the belly of the muscle in part of its course, the tendon may be lengthened here.

FIG. 204. — Insertion of tenotome under the skin across the tendon.

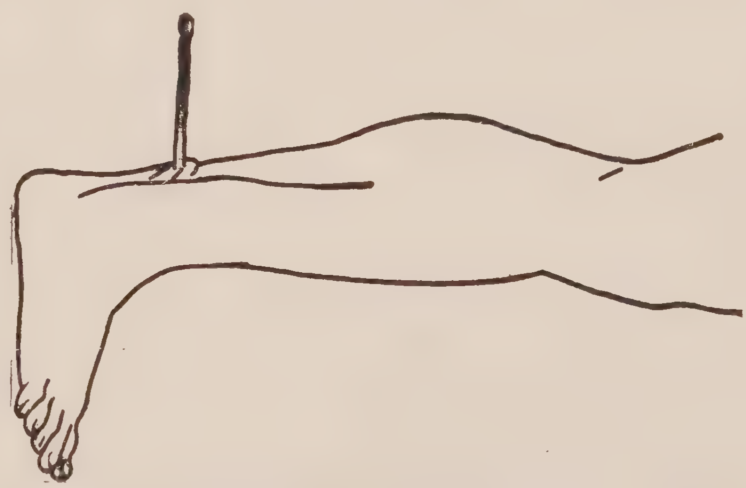

FIG. 205.—Cutting the inner half of the tendo Achilles at a higher level.

The skin incision should be to one side of the line of the tendon and when closed the fat brought over the tendons and carefully sutured. The tendons should be handled as little as possible and not injured by hard forceps or by clamping. Any ends of tendons that are to be cut away may be clamped.

In subcutaneous tenotomy of the tendo Achilles (figures 203 to 206) it may be incised posteriorly or laterally, cutting away from the skin. Cutting the skin is apt to cause small adhesions which may be avoided by cutting away from it.

An open incision and lengthening of the tendo Achilles is here described, as it is sometimes necessary. It is an unnecessary operation in the majority of cases, especially when it is done in connection with other operations which is very often the case. A subcutaneous tenotomy of the tendo Achilles may be done in a minute which does not prolong the operation to any degree. In the case of other tendons, open lengthening may be advisable and is often the operation of choice. A subcutaneous tenotomy is preferable for the Achilles tendon even when there are scars of previous tenotomies. No danger of non-union need be feared. In a large clinic where thousands of tenotomies have been done, lack of union following tenotomy has almost never been seen. Occasionally a writer reports a non-union of the tendo Achilles. In hospitals this operation is apt to be delegated to those less skilled in operating. In spite of this the cases of non-union are few. A non-union, we are led to believe, is due to the complete cutting of the sheath combined with careless after treatment. Tenotomy of the tendo Achilles is usually performed to relieve equinus, or to allow more upward motion of the foot. More detail in the technique of tenotomy is given below.

Fig. 206.—Cutting the outer half of the tendo Achilles at a lower level. When the tendon is stretched a zigzag subcutaneous tenotomy results. (See figure 201.)

Fig. 207.—Tenotomy across the tendon. Not the best method.

128. Operation for Subcutaneous Tenotomy of the Left Tendo Achilles (figure 207).—The surgeon holds the ball of the foot in the left hand. By pressure he is able to tighten or loosen the tendo Achilles. The tenotome is passed vertically through the skin. The tenotome should enter the skin some distance from the tendon (see figure 203), point X. The tendon having pierced the skin, the tendo Achilles is relaxed. The blade of the knife is passed under the skin and over the tendon until it has crossed to the other side. The

blade is then turned down on the tendon (see figures 204 to 206). The surgeon tightens the tendon with the left hand by pressure on the ball of the foot during the cutting. The last part of the tendon is torn by the tension. This saves part of the tendon sheath. The tenotome by a gentle sawing motion gradually cuts through the tendon. The cutting gives the same sensation as when celery is cut through. The tendon is stretched and the foot brought up, over-correcting the equinus. In all cases where the tendo Achilles is tenotomized the foot should be held afterward in a firm plaster of Paris bandage extending from the toes to the knee for from five to six weeks. The foot should be dorsally flexed at least twenty degrees from the right angle. Walking on the foot is allowed with the plaster in four weeks from the time of operation.

129. Operation for Talipes Equinus (see figure 159).—The position of equinus is often due to a simple contracture of the tendo Achilles readily relieved by a tenotomy. When complicated by a contracture of the other posterior tendons on both sides and the capsule and joint ligaments, stretching by means of one of the wrenches described in another chapter may be used. A tenotomy of the tendo Achilles is usually sufficient to correct the deformity when it is simple.

AFTER TREATMENT

130. Following the tenotomy, a plaster of Paris bandage is applied from the toes to below the knee; the patient may walk on the unaffected leg using crutches. It is better to remain quiet for the first five days. In the case of children, they should remain in bed for one week. It is not necessary after the first twenty-four hours that they should remain at a hospital. Where much force has been used or where it has been necessary to use wrenches, the patient had better be in a hospital until all swelling has subsided. Walking on the foot with the plaster is allowed after the fifth week a little at first. A wooden plaster, or felt wedge is put under the ball of the foot until the foot is brought down to right angles. The plaster is gradually omitted as walking improves.

In most instances the equinus is only part of one of the many deformities of the foot described below.

131. The Plaster of Paris Bandage for the Foot After Operation for Talipes Equinus.—Following a tenotomy of the tendo Achilles, the foot should be put up in a plaster of Paris dressing with plenty of well fitting padding. There should be a great deal of sheet wadding or other padding about the heel to prevent pressure here. When the surgeon has applied as much sheet wadding as he thinks necessary he should apply as much again on the heel to be sure to protect it. While the plaster is drying, no pressure should be allowed to dent the plaster, particularly at the heel. A pillow is placed under the calf of the leg reaching almost to the heel, keeping it off of the table or bed. The plaster should not bend the toes over the dorsum of the foot, but hold the whole foot evenly raised, the toes flat in line with the ball of the foot.

As soon as the plaster is dry it should be split on both sides. It may be strapped on (see figure 156) or held by means of a wet gauze bandage (see figure 158), which should be kept broad and from curling at its edges on the back of the plaster and at the side, and come together only where it is tied. Such a bandage will not slip or curl; the top of the plaster will be held securely.

Should an open operation be necessary, a careful dissection is made down to the tendon, the skin and subcutaneous incision should be to one side of the tendon and not overlying it. When the tissues have been retracted exposing the tendon, it is tenotomized either directly across (figure 207), or it is tenotomized diagonally, or it may be tenotomized above on one side, and below on the other side (see figure 202), and the tendon drawn out. Elaborate methods of tenotomy are unnecessary as they simply increase the chances of adhesions without increasing the efficiency of the tendon.

Fig. 208. — Tenotome. Narrow blade and long narrow blunt collar.

132. Subcutaneous Zigzag Tenotomy of the Tendo Achilles.—A tenotome is entered through the skin as described above (point X, figures 203 to 207). The operator holds the foot as in the case of the straight tenotomy. The preparation is the same. The object of the tenotomy is to cut the tendon at the points seen in figure 201 and then to tear the tendon. The tendon sheath is not cut on both sides at the same level (see figure 202). The surgeon holds the ball of the foot in the left hand, the tenotome is entered vertically through the skin at a point a short distance from the tendon (see figure 203) point X. The surgeon relaxes the tendon, the tenotome passes under the skin to the opposite side of the tendon, making the cut at figure 205; it is next drawn a little one side and lowered and the cut (figure 206) is made.

The operator may prefer to cut the tendon diagonally from front to back or diagonally from side to side, subcutaneously.

Figure 206 represents the position of the tenotome in making the incision on the outer side of the tendo Achilles. After the tendon is cut halfway through on the outer side, it should be cut halfway through on the inner side, at a level one-half an inch lower. In changing the position of the tenotome the surgeon relaxes the pressure on the ball of the foot so that the tendo Achilles is relaxed, allowing the tenotome to be brought easily into position. A tenotomy may be performed at almost any level. It is better, however, to operate on or

near the round portion rather than the flat portion of the tendon.

133. The Tenotome.—Figure 208 will show the proper shape of the tenotome and figure 209, the kind of tenotome usually found at instrument stores. The blade of a good tenotome is very small, one-quarter or three-eighths of an inch long and one-eighth to one-sixteenth of an inch in diameter. The neck should be strong and not sharp, and long enough to allow the blade to extend some distance inward but not so weak in the neck that it will break or bend.

Fig. 209. — Tenotome usually to be found for sale. The blade is too long and too large.

134. Operation for Open Tenotomy to Relieve Contracture of Flexor Longus Digitorum in the Lower Leg.—When this deformity accompanies extension of the metatarso phalangeal joint, the reader is referred to a fuller description under Hammer Toe.

As the patient lies on his back, the operator stands on the same side as the leg to be operated on.

An incision is made one-half inch directly posterior to the internal malleolus and two inches long, through the skin and subcutaneous fat. This is dissected up and retracted exposing the tendons, a blunt dissector raises the flexed tendon of the toes which the surgeon assures himself he has by pulling on the blunt dissector thereby contracting the toes. A zigzag tenotomy or a tendon lengthening may be done according to any of the methods described under tendon lengthening. The subcutaneous tissues are brought together with interrupted chromic catgut sutures number 00, the skin with continuous chromic catgut sutures number 00. A well padded plaster of Paris bandage is applied holding the feet dorsally flexed and the toes extended by "digit ropes" in the

Fig. 210.—Tendon lengthening in the belly of the muscle. A zigzag tenotomy may be done here. (See figure 201.)

plaster (see figure 190). The case is allowed to walk after the fifth week with plaster. At the end of eight weeks if the patient can walk well the cast is gradually omitted.

135. Subcutaneous Tenotomy of the Flexor Longus Digitorum at the Base of the Toe.—A subcutaneous tenotomy of the tendons of the toes may be made at the base of each toe or at the toe under the second phalanx. The tenotome is inserted in each case to the side of the tightened tendon which may be felt as the toe is held extended. As the tenotome is slid over the tendon the toe should be relaxed. When the blade reaches the farther end of the tendon the toe is extended allowing the rigid tendon to come in contact with the blade. The tendon is then cut across by a gentle sawing motion. As the fibers are cut they give the sensation of cutting celery. The foot is put up in plaster with toe portion hyperextending the toes. This remains on three or four weeks. The after treatment will consist of extending the toes daily. When the operation of extending the flexed tendons of the toes is done for hammer toe, the extended metacarpal phalanx joint must be corrected as well as the flexed phalangeal joint beyond, otherwise the operation is but half done. A toe splint (see figures 190 to 194), the toe wire bent to correct the deformity or foot plaster should flex the metacarpo phalangeal joint and extend the phalanges. In severe cases, apparatus should be worn constantly for six or eight weeks and gradually omitted after that. Exercises and stretching of the toes should be done daily for about a year; otherwise the tendons may contract. Apparatus in severe cases should be used an hour daily for a year.

Fig. 211.—Tenotomy of the plantar fascia. X; points of entrance for the tenotome.

136. Subcutaneous Tenotomy of the Plantar Fascia. (**Subcutaneous Tenotomy of the Left Plantar Fascia**) (figures 211 and 212).—In doing a tenotomy the shape of the tenotome is important. It should have a narrow blade about three-eighths of an inch long, such as is shown in figure 208. The operator holds the ball of the foot in the left hand and enters the tenotome perpendicularly through the skin at a point X in figure 211. The skin is lifted by the blunt part of the tenotome while the tenotome passes between the skin and the plantar fascia (figure 212), the operator being careful not to cut the under surface of the skin across the foot. The surgeon should feel carefully with

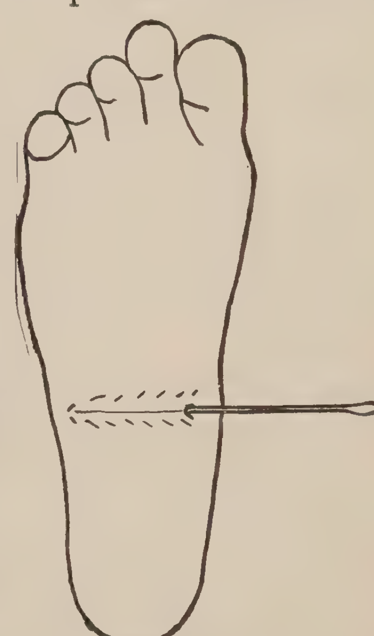

Fig. 212.—Passing the tenotome between the skin and the plantar fascia.

the fingers of the right hand for the fibers which he wishes to relieve. By a gentle sawing motion of the blade of the knife, the plantar fascia is cut across; the cutting of its fibers gives very much the same sensation as that of cutting celery. The fibers are all cut across one after another without penetrating deeply into the tissues. If the surgeon feels with his knife while he is cutting, there is no danger of extending deeply beyond the fibers of the fascia. Before withdrawing the knife the surgeon should feel for any fibers that remain uncut. It is distinctly advisable not to cut the skin, for in subsequent stretching of the foot later it is apt to be torn. The deep tendons should also be avoided. Occasionally there is some bleeding due to the cutting of small vessels. This usually does not amount to anything and requires no special treatment. Gentle pressure with the fingers is sometimes necessary when the bleeding is excessive. This condition is rare. Tenotomy of the plantar fascia is usually done in connection with other operations to correct deformity. It is often necessary in operations for the correction of equino varus, varus, equinus and cavus.

137. Operation for Contracture of the Tibialis Posticus in the Leg.—The tendon is reached as described for the flexor longus digitorum posterior to the malleolus, or it may be tenotomized in the foot below the malleolus. This operation is almost never required excepting in spastic paralysis with extreme deformity.

138. Tenotomy or Tendon Lengthening of the Peroneii Muscles.—In the case of the peroneii muscles, it is better if cutting them subcutaneously, to select a point a little forward and below the internal malleolus. The operator strongly adducts the foot, feels the tendon with the forefinger of the right hand, while he holds the tenotome between the thumb and forefinger of the same hand. When the tenotomy of the peroneii is indicated it may be done subcutaneously as in elongating any tendon as described in these pages under tenotomy of the tendo Achilles.

If the tendons are to be tenotomized back of the internal malleolus, a small incision should be made; the tendons lifted out on a blunt dissector, or director, and cut across. While this operation is desirable in certain spastic conditions and some cases of extreme flat foot and may be found necessary in certain infantile paralysis cases, it is usually better to transplant these muscles if they are strong and make them useful for either extending or flexing the foot, depending on which motion is lacking. Tendon lengthening should be done in the lower middle third of the leg; for detail, see tendon lengthening, section 127.

139. Tenotomy or Tendon Lengthening of the Tibialis Anticus.—Tenotomy of the tibialis anticus may be done subcutaneously at the inner side of the foot where it is easily felt when contracted. Its prominence may be exaggerated by abducting and pronating the foot. It is rarely indicated

The rules for lengthening the tibialis anticus and its tenotomy are the same as those described in these pages under tenotomy and tendon lengthening.

140. Tenotomy to Relieve Hammer Toe (see Hammer Toe Operation. See section 118 to 124).

141. Tenotomy to Relieve Contracted Extensor Longus Digitorum (see Description under Hammer Toe Operation).

142. Subcutaneous Tenotomy of Extensor Longus Digitorum near the Head of the Metatarsal (see Description made under Hammer Toe. Section 118 to 124).

143. Different Forms of Tenotomy to Relieve Contracted Extensor Longus Digitorum in the Lower Leg (see Description under Hammer Toe Operation 118 to 124.)

144. Operation for Tendon Shortening.—A tendon may be shortened in many different ways. A tendon extending into a muscle is shortened over the belly of the muscle (see figure 213, 214), or the tendon may be shortened below the muscle (see figures 217, 218).

Fig. 213.—Tendon shortening in the belly of the muscle. Shaded portion is removed and the space closed as shown in figure 214.

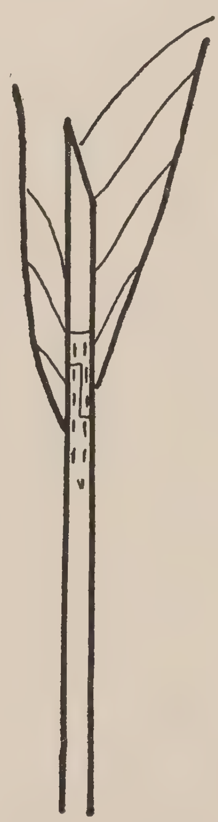

Fig. 214. — Tendon shortening sutures in place. (See figure 213.)

Two incisions are made across the tendon at right angles to its fibers and one and one-half inches apart, extending halfway through, one on the inner side and one on the outer side of the tendon. A third incision connects these two by splitting the tendon parallel to its fibers (figure 213). If it is necessary to shorten the tendon a quarter of an inch, a quarter of an inch is cut away from the end of the narrow portion of each end, as shown by the shaded marks in figure 217. The tendon is sutured as shown in figure 218.

145. Other Methods of Tendon Shortening.—The tendon may be overlapped as seen in figure 216, or it is tucked and stitched (see figures 219 and 220), or it is reefed by a quilted silk suture (see figures 218 to 222). When there is to be much strain, quilted silk sutures as suggested by Professor Lange should be used from one tendon and into the other after whatever method of shortening used. Additional mattrass sutures may be used beside.

146. Operation for Shortening the Tendo Achilles.—The patient lies face downward, the feet extend beyond the end of the operating table, or by means of a large sand bag under the lower third of the tibia, the foot is elevated allowing easy motion of the ankle in flexion and extension without touching the operating table. The operator stands on the same side as the foot to be operated on.

An incision is made two and one-half inches long parallel to, and one-half an inch to the side of, the tendo Achilles. Dissection is made in one layer down to the tendo Achilles sheath. Its sheath is opened longitudinally exposing the tendon. This is cut and overlapped (see figures 215 to 222), or tucked and stitched or reefed by quilted silk sutures. In this latter instance, the tendon shortens to the tension of the silk.

Fig. 215. — Cutting the tendon.

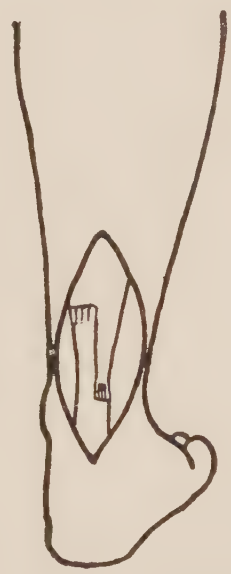

Fig. 216.—Slitting and reefing a zigzag tenotomy. The shortening desired is marked in shadow.

Fig. 217.—Tendon shortened and sutured, completed.

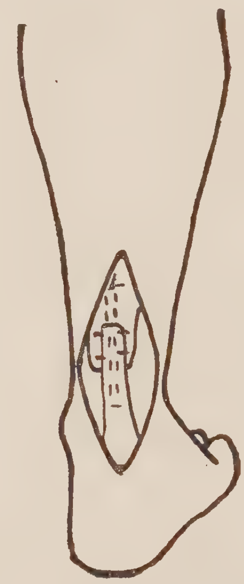

Fig. 218.—Reefing with quilted sutures. Cutting and overlapping the tendon.

The sheath is closed by small catgut sutures, the retracted skin and fat allowed to slip in position and closed by interrupted chromic catgut sutures number 00, the skin with continuous chromic catgut sutures number 00. Plenty of sheet wadding is applied over a very small gauze dry dressing. The heel is protected by three or four extra thicknesses of sheet wadding. A plaster of Paris dressing is applied snugly, holding the foot in an equinus position. The patient is allowed to walk on the foot in four weeks with the plaster on and a block under the heel. In seven weeks the plaster is gradually discarded.

147. Operation for Shortening the Extensor Longus Digitorum.—The patient lies on his back, the operator stands on the side of the leg to be operated on.

An incision is made two inches long, through the skin and fat over the front and lower third of the leg. The skin and subcutaneous fat are retracted exposing the extensor tendons. Lifting each tendon on a

blunt instrument will give sufficient pull to show to which toe it extends.

Each extensor tendon is shortened by one of the methods described in these pages under Tendon Shortening. The foot is put up in plaster

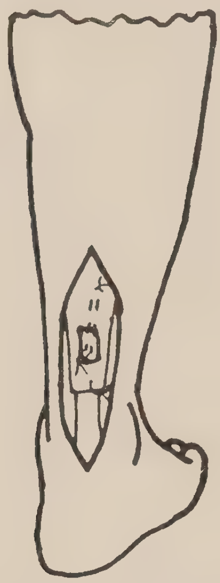

Fig. 219. — Tucking and reefing, slitting the tendon before suture.

Fig. 220. — Tucking and reefing without cutting the tendon.

Fig. 221. — Quilted suture applied.

in marked dorsal flexion. The patient walks for two weeks with the plaster. After six weeks the plaster is discarded as rapidly as possible.

Fig. 222.—Quilted suture reef pulled and tied.

The operation is necessary only in cases with contracture of the flexors or of the joint that has existed for a long time. The flexors will often have to be lengthened or tenotomized.

148. Lange Method. Operation for a Weak or Paralyzed Tibialis Anticus. Transplantation of the Peroneii Muscles Forward to Give Dorsal Motion to the Foot.—The patient lies on his back, a sand bag under the ankle; the operator stands on the same side of the table as the leg to be operated on. A rubber bandage is applied from the toes to just above the knee where a tourniquet is applied over a towel. The leg is prepared with scrupulous care as to aseptic detail.

An incision is made one inch above and one-half an inch posterior to the tip of the external malleolus extending upward to the middle of the leg parallel to the fibula (figure 223). An incision extending around the external malleolus and close to the bone is undesirable as the scar is sometimes painful to the patient later on. The strong fibrinous sheath

and rectaculum about the malleolus should not be opened or cut. In this way the joint will not be weakened unnecessarily. The incision is carried down to the peronei muscles which should be examined before transplanting. If red they will be vigorous and very good for transplanting, if pink they will not be quite as serviceable, if gray or grayish pink they will not be useful for transplantation. The lower end of the incision is pulled downward by a hooked retractor, allowing access to the tendons below the incisions (figure 224).

FIG. 223.—Incision for reaching the peroneii muscles.

FIG. 224.—Retraction of wound below, exposing peroneii tendons, below the incision.

Frequently both the long and short peronei are transplanted at the same time. They are cut below as shown in figure 225, the detached ends held in a hemestatic. The clamped tip is cut away later. The operator dissects the muscles from the bone with a scapel until a good line of cleavage is reached, then he may continue the dissecting, using a sponge. He should avoid injuring the branch from the external popliteal nerve which lies near the bone

FIG. 225.—Cutting the peroneii tendons.

anterior to these muscles and is apt to be rolled up in the separated muscle sheath as it folds over it. Next an incision two inches long is made over the anterior and middle aspect of the leg down to the fibers of the tibialis anticus. A subcutaneous tunnel is made under the fat

connecting this incision with the upper end of the first, a long clamp or tendon carrier is passed through the tunnel backward grasping the peronei tendons, bringing them forward as shown in figure 226. Sterile

FIG. 226.—Pulling the peronei tendons forward out through the anterior incision.

towels are placed above and below this muscle as it protrudes through the anterior incisions while heavy number eighteen silk is quilted up one side of the tendon and down the other side as shown in figure 227. The silk should be pulled and tested to see that it is strong before inserting it into the tendon. The tendon quilting should be done very carefully. The needle is passed vertically through the tendon as shown in figure 227 in order not to tear the tendon fibers. The needle is not inserted twice in exactly the same line as this favors splitting of the tendon. About eight stitches should be made in this way on either side of the tendon.

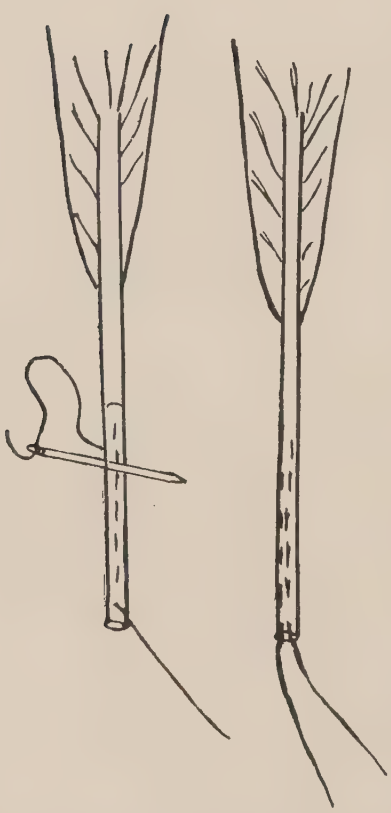

FIG. 227. — Method of quilting the silk into the tendon, and method of placing needle at right angles to the tendon fibres when inserting the silk.

The muscle and silk are now turned upward and covered with a sterile towel while the tunnel is made in or under the subcutaneous fat down to the midtarsus region. The point of insertion in the tarsus is determined by the deformity, and the unparalyzed muscles remaining. The pull of the transplanted muscle and those remaining should bring the foot up with an even degree of pronation and supination. If the tibialis anticus is paralyzed, the insertion is placed about the middle of the midtarsus. If this muscle is present to a slight degree, insertion may be placed further to the outer side.

The point of insertion having been selected, a curved flap is made so that its base overlies (see figure 226) the point at which the silk is to be inserted. The flap should take with it in one layer, the subcutaneous fat and fascia. It should be slightly curved and laid out not to cut off the circulation at its proximal end. By means of a tendon carrier (figure 228), a tunnel is made in the subcutaneous

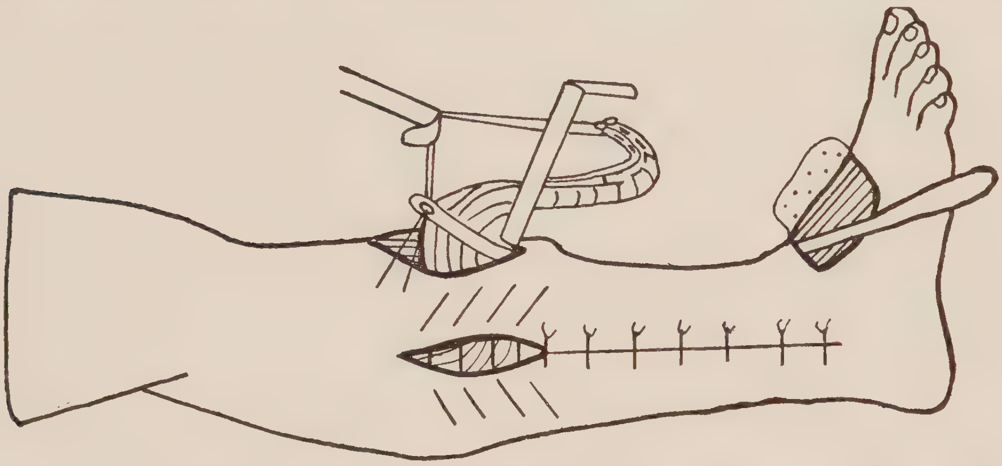

Fig. 228.—Tunnel from the foot to the anterior leg incision method of retracting the lower end of the anterior leg incision to prevent inversion of the subcutaneous tissues while drawing the muscle downward.

fat connecting the anterior leg incision with the foot incision. A long tendon carrier (see figure 230) is passed from the foot incision upward, or the reverse; the silk is threaded in the eye of the carrier. The lower end of the incision on the front of the leg is held raised by means of a retractor as shown in figure 228 to prevent inversion of the fat while the muscles and tendons are drawn downward. If the trans-

Fig. 229.—Quilting of the silk tendon extension into the periosteum of the tarsus.

plantation is done in an adult with very long legs, it is sometimes necessary to have an opening in the front of the leg halfway between the upper incision and the foot. The silk, the tendon and muscle are then pulled down to this incision and then to the foot. The silk, the tendon and muscle are drawn through the tunnel and the silk protrudes at the tarsal incision as shown in figures 228 and 229. The

silk is next inserted into the periosteum of the tarsus by quilted sutures (see figures 231, 232, 281). The operator is careful that the part of the silk in the eye of the needle or any part clamped is the part to be cut away later. The silk to remain in the patient should not be clamped nor put through the eye of the needle. Before tying, each strand is pulled upon so that it will be tense, holding the foot in a position of slight dorsal flexion. The operator should assure himself that the muscle is not caught at any one point in the tunnel and that it will slide freely as far as it will, before inserting the silk into the periosteum of the foot, otherwise there may be relaxation of the silk during convalescence. When the silk is tied, it should hold the foot above the desired position. After being tied three times, the knot is pressed into

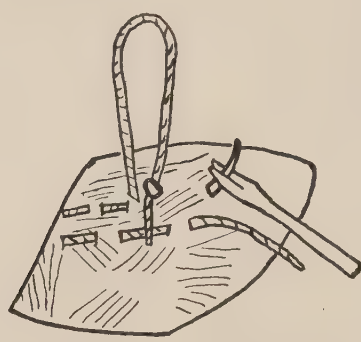

Fig. 231. — Needle and silk being inserted into the periosteum.

Fig. 232. — Silk quilted into the periosteum.

the periosteum so that it will lie flat. It is then covered over by the muscle fibers or tendons in the foot. The deep tissues are brought together with interrupted chromic catgut sutures number 00, the subcutaneous fat with interrupted chromic catgut sutures number 00, the skin with continuous chromic catgut sutures number 00. Six layers of gauze are placed over each wound extending one-half inch beyond the ends of incisions and about one inch or one and one-half inches broad.

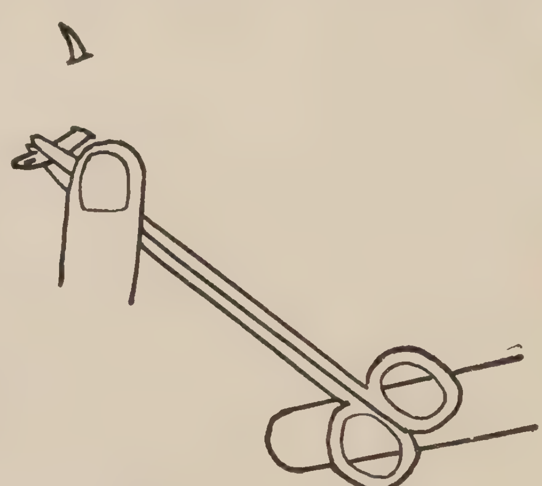

Fig. 233.—Method of applying force with the finger close to the needle, while inserting the needle into the periosteum or bone to avoid breaking the needle. No pressure is used to twist the handle of the needle holder.

Fig. 230. — Tendon carrier.

149. Plaster of Paris.—This size dressing facilitates inspection later on without interfering with the plaster. A large fold or roll of

loose sterile sheet wadding is placed over the front of the leg to prevent pressure on the transplanted muscle (see figures 234 to 235); over this sheet wadding rollers are placed before applying the plaster of Paris bandage. The plaster of Paris bandage should reach from the toes to the groin with the foot slightly overcorrected, relaxing the tendon and silk. The plaster is split on each side allowing the front to be lifted or removed for inspection of the dressing. The foot should be manipulated before operating so that its action is free and normal in all directions. If the tendo Achilles is short this must be relieved before doing any transplantation to the front of the foot. When this has been accomplished then a tendon transplantation may be performed. A strong tendon Achilles should be tenotomized when muscles are transplanted to the front of the foot. When there is much swelling after the operation the front of the plaster is raised allowing one-half inch gap on both sides of the plaster from the toes to the upper thigh. If necessary the sheet wadding roll on the front of the leg is removed and the sheet wadding split along the whole front of the leg, exposing the skin from the toes to the groin. This will prevent any constriction from bands of sheet wadding. This need not be done unless there is much swelling. There is usually considerable swelling after a muscle transplantation. It will be very much less if the operator handles the tissues carefully and avoids all roughness in the manipulation of the joints and transplanted tissues. Unnecessary roughness is especially to be avoided in making the subcutaneous

FIG. 234.—Roll of sheet wadding applied after tendon transplantation to prevent pressure of the plaster over the transplanted muscle.

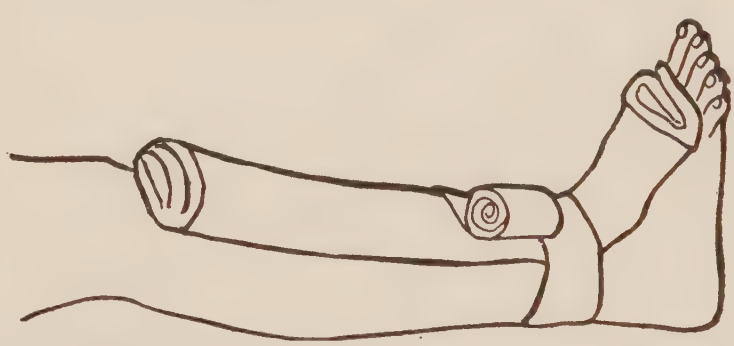

FIG. 235.—Sheet wadding rollers being applied over the large sheet wadding roll.

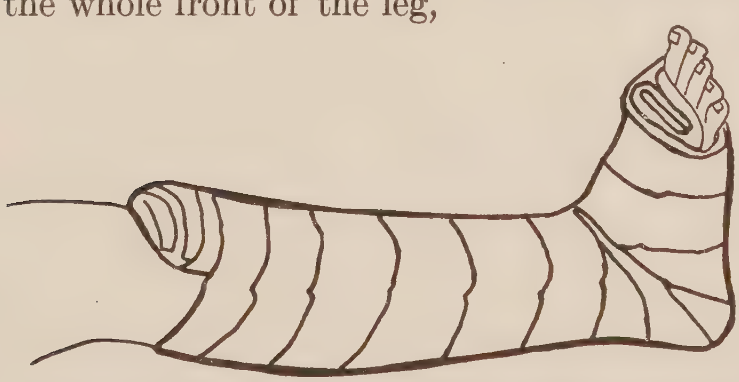

FIG. 236.—Sheet wadding rollers applied ready for plaster. After muscle transplantation the whole leg and foot should be included in the plaster.

tunnels. The incisions may be inspected on the fifth or seventh or tenth day and fresh dressing applied. If there is the slightest moisture, an alcohol dressing is applied and repeated in two days; after that the dressing should be dry (see healing of wounds in infantile cases under general consideration).

150. After Treatment.—The patient should be encouraged to move as little as possible for the first five days; pillows are allowed then, raising the patient forty-five degrees. He may turn on his side at the end of ten days. At that time a bed rest is allowed. The patient is kept very quiet for six weeks. After that he is allowed to be in a go-cart or in a wheel chair. He walks with crutches in the eighth week. Weight-bearing with the plaster is allowed after the eighth week. When walking is easy with the plaster, a short caliper is used with a double ankle stop. The braces are used during the day, a plaster of Paris at night holding the foot at right angles. Special exercises and muscle training are started the seventh week after operation and continued for a year at least. Great care should be taken not to stretch the foot downward for about a year. The shoe and stocking should be removed with an upward and not downward pull. Much may be expected from the transplantation of the peronei muscles, especially when they are red and large. Great care should be used in selecting the insertion with reference to the deformity and the pull of the muscles that will exist after transplantation. The peronei or any other muscle should not be transplanted to give power to raise the foot without doing something to give good lateral stability at the ankle joint if this is flail or very weak (see operations for flail ankle). A muscle when carefully transplanted will give strength where it is placed and take up the new motion, but it must not be expected to give strength and lateral stability besides. Any joint deficiency must be compensated for either before or at the time of transplanting. In any transplantation, one-half of the lower end of the tendon to be trans-

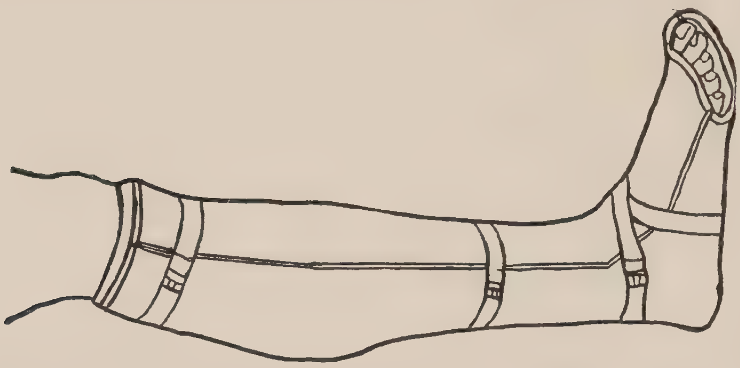

Fig. 237.—A method of splitting a plaster of Paris bandage; webbing straps hold the plaster together. A plaster to the groin should be used after muscle transplantation.

Fig. 238.—Plaster of Paris bandage, split and held with a three inch gauze bandage wet and placed at intervals.

planted may be left, and a tendon fixation done with it (see Tendon Fixation).

The principles for joint stability considered under the different deformities are applicable in connection with the various transplantations. Sections 109 and 110. Whenever transplanting a muscle or tendon when it will reach the bone, it can be placed in a groove under the periosteum as recommended by Dr. Vulpius. When it will not reach, silk elongation is most satisfactory.

151. Operation for a Weak or Paralyzed Tibialis Anticus. Transplantation of the Tibialis Posticus Forward to give Dorsal Motion to the Foot.—The patient lies on his back with his leg outwardly rotated, a sand bag or heavy pillow may be placed under the buttock of the opposite side; the operator stands on the same side as the leg to be operated on.

OPERATION

An incision is made parallel to the tibia extending one inch above and one-half inch posterior to the internal malleolus, extending up to the middle of the leg and down to the muscle layer. The tibialis posticus tendon is lifted on a blunt dissector. It may be distinguished from the long flexor of the toe as the latter will contract the toes when forcibly lifted on the blunt dissector. An assistant holds the incision retracted downward while the tibialis posticus tendon is drawn up and cut away below. The tendon tip is held in the hemastatic, the compressed part is cut away later. The tendon and muscle are dissected up to the middle of the leg. An incision is made over the front and middle of the tibia, a tunnel is made from the upper end of the first incision subcutaneously to the incision on the anterior part of the leg. A tendon carrier or long clamp is passed from the anterior incision backward, grasps the tip of the tibialis posticus tendon, draws it forward followed by its muscle. Sterile towels are placed above and below the muscle, while silk is quilted up one side and down the other side as shown in figure 227. In inserting the needle through the tendon it should be passed vertically through in order not to tear the fibers as shown in figure 227. The muscle and silk are turned upward and covered with a sterile towel while a tunnel is made in or under the subcutaneous fat down to the midtarsus region. The point of insertion in the midtarsus is determined by the unparalyzed muscles remaining. If the tibialis anticus is paralyzed, the insertion may be made about the middle of the midtarsus at B, figure 247. If this muscle is present to a slight degree, insertion may be made further to the outer side (C, figure 247). The point of insertion having been selected, a curved flap is made so that its base overlies the point at which the silk is to be inserted (figure 226). The flap should take with it in one layer the subcutaneous fat and fascia and extend to the layer of the tendons and muscles. Its curve should be slight and laid out not to cut off the circulation at its proximal end. A subcuta-

neous tunnel is made by means of a tendon carrier (see figure 230), from the incision at the front of the leg to the incision in the foot. The lower end of the upper incision is carefully held up by means of a retractor (figure 228) to prevent inversion of the fat while the muscles and tendons are drawn downward. The muscle is drawn through the tunnel and the silk protrudes through the incision at the tarsus as shown in figure 229. The silk is quilted in the periosteum as shown in figures 231 and 232. Before tying, each strand is pulled upon so that it will be tense, holding the foot in a position of very slight dorsal flexion. The operator should assure himself that the muscle is not caught at any one point in the tunnel and that it will slide freely as far as it will go before inserting the silk in the periosteum of the foot, otherwise there may be relaxation of the silk during the convalescence. When the silk is tied the foot should be held in the desired position in slight dorsal flexion. After being tied the knot is pressed flat and covered over by the muscle fibers or tendons in the foot, then the deep tissues are brought together with interrupted chromic catgut sutures number 00, the subcutaneous fat with interrupted chromic sutures number 00, and the skin with continuous chromic catgut sutures number 00. Six layers of gauze are placed over each wound extending one-half inch beyond the ends of incision and about one inch or one and one-half inches broad. This size dressing facilitates the inspection of the wound later on without interfering with the plaster. Sterile sheet wadding should be applied with a large fold or roll of loose sheet wadding over the front of the leg to prevent pressure from the plaster on the transplanted muscle (see figures 234 to 236). After this sheet wadding rollers are applied; a plaster of Paris bandage is next applied from the toes to the groin with the foot slightly overcorrected, relaxing the tendon and silk.

Before operation for transplantation forward at the ankle, if the tendo Achilles is extremely strong it is well to do a tenotomy. The foot should be manipulated so that its action is free and normal in all directions. When this has been accomplished a tendon transplantation may be performed. The after care in this operation is the same as that laid down for transplantation of the peronei muscles forward.

In using the tibialis posticus for transplantation it may be well to slit the tendon longitudinally and take half of the tendon with the whole muscle for transplantation as described above. The half of the tendon remaining attached below can be used to fix the joint as described under tendon fixation. This will prevent pronation and weakening of the joint laterally. The rules that govern joint stability should be observed as described under transplantation of the peronei muscles and as described under the various foot deformities. Sections 109 and 110.

152. Operation for a Weak or Paralyzed Tibialis Anticus. Transplantation of the Flexor Longus Digitorum to Give Dorsal Motion to the Foot.—This operation differs in no way from the transplantation

of the tibialis posticus forward excepting in the use of the long flexor of the toes instead of the tibialis posticus. The operative consideration and the after care are the same.

153. Operation for a Weak or Paralyzed Tibialis Anticus. Transferring the Extensor Longus Hallucis to Re-enforce the Tibialis Anticus in the Lower Third of the Leg.—The patient lies on his back, the operator stands on the side of the leg to be operated on.

An incision is made two inches long through the skin and fat over the front and lower third of the leg. The skin and subcutaneous fat are retracted and the extensor tendons are exposed. Lifting each tendon on a

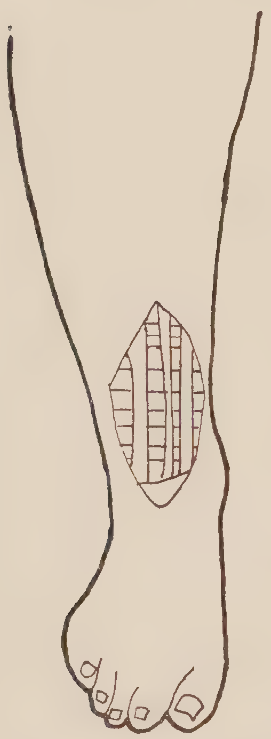

Fig. 239.—Exposure of the tibialis anticus and extensor longus hallucis in the lower third of the leg.

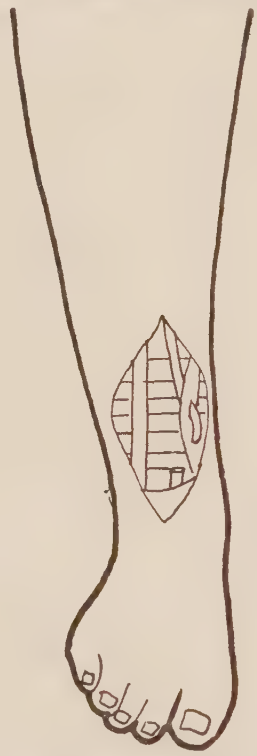

Fig. 240.—The extensor longus hallucis transferred to re-enforce the tibialis anticus in the lower third of the leg. (See figure 239.)

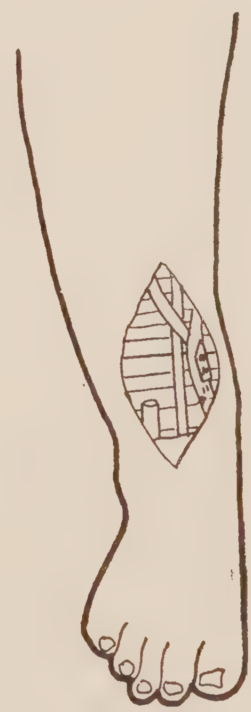

Fig. 241.—The extensor longus hallucis sutured after being transferred to the tibialis anticus.

blunt instrument will give sufficient pull to show to which toe it extends. The extensor of the great toe is isolated and cut, the proximal end is placed through a slit in the tibialis anticus tendon and pulled into the slit until it relaxes, the tibialis muscle slightly above the slit. Quilted sutures are then used to unite both tendons; either mattrass sutures or quilted sutures are used (see figures 239 to 241). The wound is closed up in slight dorsal flexion, relieving the strain on the transplanted muscle. After six weeks the patient walks for two weeks with the plaster, after that it is removed gradually. When the tibialis anticus is nearly completely paralyzed, a short caliper brace with a double stop at the ankle is worn for about a year during the day and a plaster or posterior wire splint is worn at night. The latter reaches from the toes to below

the knee. Muscle training and special exercise should be done for a year or more.

154. Operation for Transplantation of the Extensor Longus Hallucis to the Tarsus for Weak or Paralyzed Tibialis Anticus.—A transplantation of the extensor longus hallucis may be done to the tarsus, to the metatarsal or in the lower third of the leg to the tibialis anticus. This operation is often done in addition to transplanting other muscles such as the peroneii forward. Besides giving added power to raise the foot, it will decrease the tendency to hammer toe when this is developing.

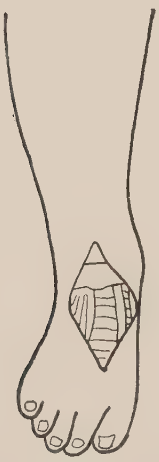

FIG. 242.—Incision on the dorsum of the foot exposing the extensor tendons.

FIG. 243. — Silk quilted into the extensor longus hallucis which is ready to be placed into the slit tibialis anticus tendon.

FIG. 244. — Insertion of the extensor longus hallucis into the slit tibialis anticus tendon.

Operation for a Weak or Paralyzed Tibialis Anticus. Transplantation of the Extensor Longus Hallucis to the Tendon in the Foot.—An incision is made over dorsum of the foot, the tendon is cut away from the toe at the dorsum of the foot, silk is quilted up one side and down the other of the tendon and the tendon fastened into the periosteum of the bone by means of this silk which is quilted into the periosteum (see figures 242 to 244). The operative technique, the operative considerations, and the after treatment are all similar to that considered under transplantation of the peroneii forward and under deformities of the foot and ankle. Sections 151, 109, 110.

155. Transplantation of the Extensor Longus Digitorum to the Tarsus to Raise the Foot; for a Weak or Paralyzed Tibialis Anticus.—The patient lies on his back, the operator stands on the same side as the leg to be operated on, a sand bag is placed under the ankle.

A longitudinal incision is made over the dorsum of the foot from the base of the third metatarsal to the annular ligament (figure 258). The extensor tendons of the four outer toes are cut away as low down as possible. The foot is brought up to a dorsal position twenty degrees from a right angle. The tendons are cut long enough so that when attached to the periosteum of the tarsal bones they will hold the foot

in position. The silk is quilted up one side and down the other side of the tendons as shown in figure 227. This quilting must be done high on the tendons as the operator will see. This may be done in pairs or all four tendons may be quilted at the same time. The lower end of the silk is quilted into the periosteum overlying the tarsal bones (see figure 232). The point selected for the insertion of this silk into the tarsus will depend largely on the deformity and the muscles that are paralyzed (see General Considerations in Muscle Transplantation and Foot Deformities). Sections 109, 110. If the tibialis posticus is strong, these tendons may be transplanted outward to re-enforce the action of the peronei muscles. If the tibialis anticus is paralyzed, and the

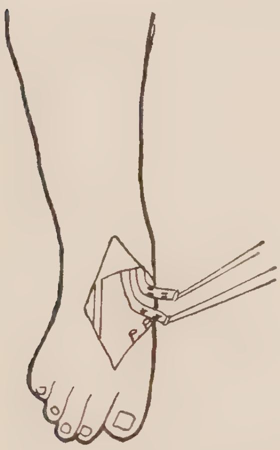

Fig. 245. — Insertion of quilted silk sutures into the cut tendons of the tibialis anticus and the extensor longus hallucis.

Fig. 246. — Insertion of the tendons by quilted silk sutures into the periosteum at the middle of the tarsus.

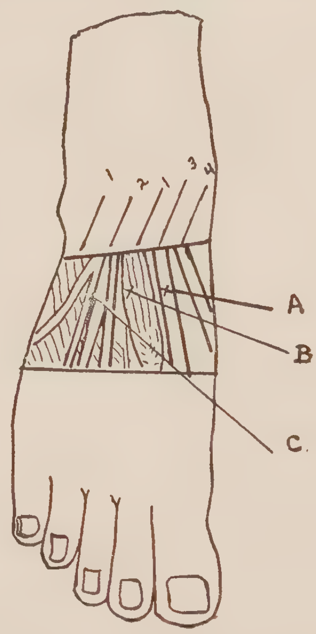

Fig. 247.—Points of insertion in the tarsus for tendons or silk ligaments.

tibialis posticus is gone, these tendons should be transplanted to the inner side of the foot to raise the foot (see figures 245–246) and counter-balance the peronei muscles. If the peronei and tibialis anticus and tibialis posticus are all gone, it will be of advantage to attach these tendons in the middle of the foot or to place two to the outer side and two to the inner side. The mechanical action of the foot before transplantation should be observed and also the relative strength of the muscles to be transferred.

The operative consideration and after treatment are similar to that described for transplantation of the peronei forward. If the tendo Achilles is short, this must be relieved before any transplantation to the front of the foot.

156. Operation for a Weak or Paralyzed Tibialis Anticus. Transplantation of the Extensor Longus Digitorum to the Tibialis Anticus in the Lower Third of the Leg.—The extensor longus digitorum may be transplanted to the tibialis anticus tendon. An incision two and one-half inches long is made on the anterior aspect of the lower third of the tibia and parallel to it.

The extensor tendons are drawn up and cut away below. A slit is made in the tibialis anticus tendon.

The detail of this operation and the after treatment is the same as that described for the transplantation of the extensor longus hallucis into the tendon of the tibialis anticus. See section 153.

157. Transplantation of the Extensor Longus Hallucis to the Head of the Metatarsal.—This may be done by an incision over the dorsum of the foot two inches long extending from the joint upward. The dissection is carried down to the tendon, the incision is stretched downward by retractors and the tendon cut away below. As it is held up it is slit with a tenotome

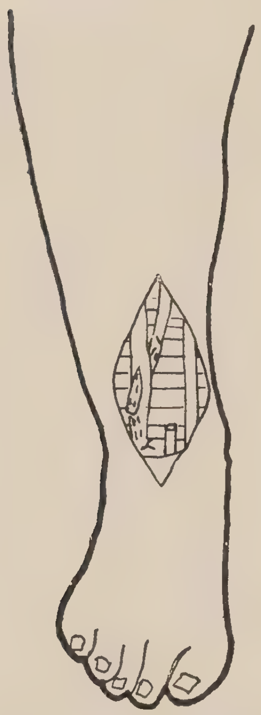

Fig. 248. — The extensor longus hallucis transferred to re-enforce the long extensor tendons of the toes.

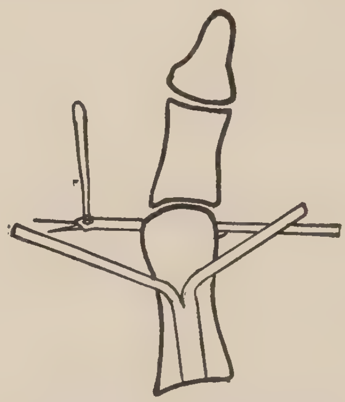

Fig. 249.—Drilling the head of the metatarsal; cut and split extensor tendon. (Silk wormgut leader doubled and placed in the drill end).

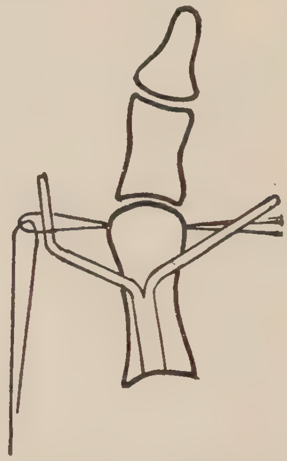

Fig. 250.—Two silk wormgut leaders, one looped into the first which protrudes through the drill hole in the bone. Slit tendon ready to be pulled through the bone.

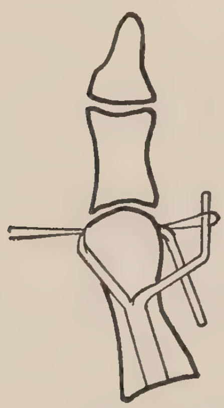

Fig. 251. — Split tendon passed through the bone. The second silk wormgut leader ready to carry the other end of the tendon through the bone in the opposite direction.

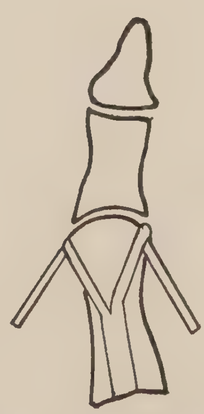

Fig. 252. — Both ends of the split tendon passed through the bone.

Fig. 253.—Suture of the tendon ends to the unsplit portion of the tendon.

(figure 249). The head of the metatarsal is drilled in its end. The two ends of a piece of silk wormgut are threaded through this hole (see

figure 250), and drawn through the bone. The loop acts as a leader to draw the split tendon through the bone (figure 251). The operator should be careful to use a large size drill in order that the hole will be large enough to allow the tendon to be drawn through easily. A second loop of silk wormgut is passed through the first loop and drawn through the bone with one end of the slit tendon (figure 250). As the end of the tendon emerges from the other side of the bone it is grasped at its end by a small hemastatic and pulled tightly. The clamped tip is cut away later. The projecting loop of silk wormgut which has just been pulled through with the tendon is now ready to receive the other end of the slit tendon (see figure 251).

This end is pulled through the bone in an opposite direction from its fellow (see figure 252).

An assistant holds the foot in dorsal flexion during the application of the tendon to the bone. The two tendon ends are drawn tight and

FIG. 254.—A method of suturing the tendon to the capsule and periosteum with silk.

FIG. 255.—Method of using silk sutures to hold the split tendon.

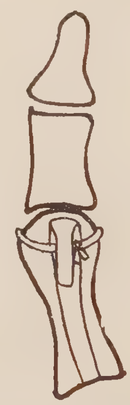

FIG. 256.—A silk loop passed through the head of the metatarsal receives the tendon; it is then turned over and sutured. (See figure 257.)

folded over the dorsum of the metatarsus where they meet (see figure 253), and are sutured together with interrupted chromic catgut sutures number 00 and at the same time sutured to the tendon from which they come above its division (see figure 253). The deep tissues are brought together over them with interrupted chromic catgut sutures number 00, the subcutaneous fat with interrupted chromic catgut sutures number 00, the skin with continuous chromic catgut sutures number 00. Other methods of suture are suggested in figures 254, 255, 257. In judging the tension on the tendon of the transplanted extensor hallucis, the operator should see that it maintains the foot at a right angle before the sutures are placed. A plaster well padded with sheet wadding is applied from the toes to the knee. The patient is allowed to walk with the plaster at the end of the third week if no other operation has been done. The muscles should be trained and exercised. The after care otherwise is the same as that for transplantation of the peroneii.

158. Transplantation of the Extensor Longus Digitorum in Paralysis of the Tibialis Anticus or when the Tibialis Anticus is very Weak.—The extensor longus digitorum is very useful for transplantation to give power to raise the foot when the tibialis anticus is weak or paralyzed. This transplantation may be used in addition to other transplantations of muscles placed forward, especially when these muscles are strong and are causing deformity. When the patient is raising the foot largely by the power of the external longus digitorum as is often the case in paralysis of the tibialis anticus, and other paralyses, a hammer toe and claw foot is developing either from the strong action of the long extensors of the toes or from the weak opponents or both. In this instance a transplantation is doubly useful. The tendons may be transplanted to the tarsus altogether or in pairs, they may be transplanted to the head of the metatarsals or they may be inserted into the tibialis anticus tendon in the lower third of the leg. The consideration of the insertion of transplanted tendons is discussed separately (see sections 109, 110) under transplantation of the peroneii and under the various deformities of the ankle and foot (see also Hammer Toe, sections 118 to 124). Persistent extension of the toes gives a permanent deformity, and causes a callous under the ball of the toes sooner or later.

Fig. 257.—Suture of the tendon passed over the silk loop. (See figure 250.)

159. Transplantation of the Extensor Longus Digitorum to the Head of the Metatarsal to give Power to Raise the Foot.—The extensor longus digitorum tendons may each be put into the head of its metatarsals as already described for the extensor longus hallucis. Section 158.

The after treatment is the same as for transplantation of the peroneii muscles forward.

160. Operation for Paralysis of the Tibialis Anticus. Transplantation of One-half of the Tendo Achilles Forward.—One-half of the tendo Achilles may be brought forward with one-half of its muscle and transplanted into the tibialis anticus tendon or into the tarsus as described for the tibialis posticus forward. With this operation a tendon fixation may be done with one-half of the tibialis anticus and one-half of the tibialis posticus. The after treatment is the same as for transplantation of the tibialis posticus forward.

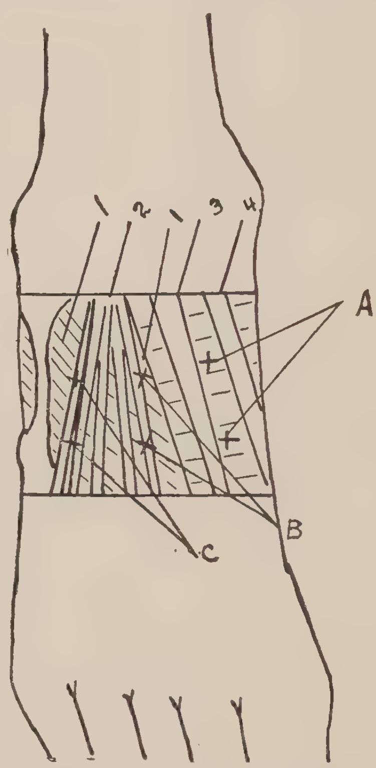

Fig. 258.—The dorsum of the foot. 1. Extensor brevis. 2. Extensor longus. 3. Extensor hallucis. 4. Tibialis anticus. A, B, and C are good points for the silk insertion, under the muscles, whenever possible.

161. Operation for Partial or Total Paralysis of the Peroneii. Transplantation of one-half of the Tendo Achilles Forward.—When the peroneii are paralyzed or very weak and there is no other better procedure to restore the usefulness of the foot, if the tendo Achilles is extremely strong, this tendon may be slit upward from the os-calcis and one-half of the tendon and muscle transplanted forward.

An incision is made one-half way between the external malleolus and the outer edge of the tendo Achilles extending upward to the middle of the leg. The incision is dissected up and retracted exposing the tendo Achilles and its muscle and the peroneii tendons with their muscles. The outer half of the Achilles tendon is cut away below at the os-calcis and dissected up and carried forward and attached to the peroneii tendons, as follows; the tendon is drawn down along the peroneii and inserted through the slit made in the peroneii; a silk suture is first quilted into the half Achilles tendon. This silk is quilted into the peroneii tendons holding the foot in slight equinus valgus. The deep sutures are brought together with interrupted chromic catgut sutures number 00, the subcutaneous fat with interrupted chromic catgut sutures number 00, the skin with continuous chromic catgut sutures number 00. A plaster of Paris bandage is applied from the toes to the groin.

In selected cases this procedure will correct a slight varus and give power to abduct the foot. The after treatment is the same as prescribed for transplantation of the peroneii forward, excepting that the foot is put up in an equino valgus and held there by a plaster for six weeks, later a brace is used and the heel and shoe built up to maintain this position for about six months. After that the foot is put up in this extreme position a short time each day.

Fig. 259. — Incision one-half way between the tendo Achilles and the peroneii tendons.

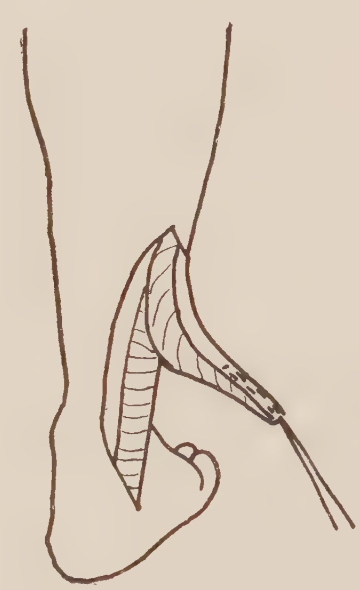

Fig. 260.—The peroneii muscles dissected up and quilted with silk.

162. Operation for Total or Partial Paralysis of the Tibialis Posticus. Transplantation of one-half of the Tendo Achilles.—One-half of the tendo Achilles is transplanted forward, into the tibialis posticus, done on the inner side of the leg as described for paralysis of the peroneii tendons.

The post operative treatment is the same; the foot, however, should be put up in a position of equino varus. With this operation one-half of the tibialis posticus may be attached to the internal malleolus (see Tendon Fixation for Valgus).

163. Operation for Transplantation of the Flexor Longus Digitorum for a Weak Tendo Achilles.—This operation is identical with the operation for transplantation of the tibialis posticus excepting that the long flexor digitorum tendon is used. It is readily recognized by the surgeon; as he raises the tendon on a blunt dissector it will cause the toes to contract.

The after treatment is the same as that for transplantation of the peroneii.

164. Operation for Transplantation of the Tibialis Posticus for a Weak Tendo Achilles.—The tibialis posticus tendon may be substituted for the flexor longus digitorum in the above operation.

165. Transplantation of Peroneii to the Tendo Achilles.—Where the tendo Achilles is weak or paralyzed, one or both of the peroneii tendons may be transplanted backward (see figures 259 to 261), and passed through a slit in the tendo Achilles and attached to it by quilted silk sutures. The distal ends of the peroneii tendons, one or both or part of one or both, are attached to the malleolus (see Tendon Fixation). This transplantation is often done in case of calcaneous at the same time that an astragalectomy is done with displacement of the foot backward. See section 168.

FIG. 261. — The peroneii inserted through the tendo Achilles and fastened with silk sutures.

When the tibialis posticus is paralyzed one of the peroneii may be transferred to it; it is transplanted into the posterior tibial tendon back of the internal malleolus. The line of the muscle is changed at the middle of the calf. The transplanted tendon is quilted with silk in the usual way, then passed through a slit in the tibialis posticus tendon and the silk quilted and tied in this tendon. The inner half of the tendo Achilles and its muscle may be used for the same purpose as described for the transfer of its outer half to the peroneii.

166. Operation for Paralysis of Extensor of the Great Toe. (Transplantation of its Distal End to that of the Tibialis Anticus).—The patient lies on his back, the operator stands on the side of the leg to be operated on.

An incision is made two inches long through the skin and fat over the anterior lower third of the leg. The skin and subcutaneous fat are retracted and the extensor tendons are exposed. Lifting each tendon on a blunt instrument will give sufficient pull to show to which toe it extends.

The distal end of the extensor tendon of the great toe is isolated and sutured through a slit made in the tibialis anticus. The degree of tension should be carefully estimated in order not to cause a hammer toe. The tension should be a little less than that of the tibialis tendons. A plaster is applied with the foot at right angles. After three or four weeks the

patient walks on the foot with the plaster. After that it is gradually omitted as walking improves.

167. Operation for Transplantation of the Tibialis Posticus to the Tendo Achilles.—The patient lies on his back, with his leg outwardly rotated, a sand bag or heavy pillow may be placed under the buttock of the opposite side. The operator stands on the same side of the table as the leg to be operated on.

OPERATION

An incision is made parallel to the tibia extending one inch above and one-half an inch posterior to the internal malleolus, extending up to the middle and upper third of the leg. The tibialis posticus tendon is isolated and held on a blunt dissector. It may be distinguished from the long flexor of the toe as the latter will contract the toes when lifted on a blunt dissector. An assistant holds the incision retracted downward by a hooked retractor and the tibialis posticus tendon is cut away low down, unless half of it is to be attached to the internal malleolus (see Tendon Fixation for Valgus). The tendon and muscles are dissected up to the middle of the leg. Two sterile towels are placed about the tibialis posticus muscle, one above and the other below. The tendon tip is held by the hemastatic while the operator quilts silk up one side and down the other (see figure 227). The silk is carefully tested before inserting it into the tendon, a heavy number sixteen or number eighteen braided silk is used. The incision is next retracted exposing the tendo Achilles extending downward from the junction of the middle and lower third of the leg. The tendon of the tibialis posticus is placed through a slit in the tendo Achilles and sutured there by means of quilted silk sutures as shown in figure 261. The operation is sometimes done in connection with an astragalectomy when there is paralysis of the posterior muscles. The plaster and after treatment is the same as that for transplantation of the peroneii muscles, excepting that the foot is put in a few degrees of equinus. A plaster or wooden heel is used for early locomotion with the plaster on.

CHAPTER III

OPERATION IN CASES OF PARTIAL OR TOTAL PARALYSIS ABOUT THE ANKLE. (SEE ALSO CHAPTER II)

168. Astragalectomy and Displacement of the Foot Backward for Flail, Partially Flail or Foot Operation.—(Devised by Dr. Whitman).

OPERATION

The patient lies on his back, the operator stands on the same side of the table as the ankle to be operated on. One of two incisions may be used; either an incision starting posterior to the external malleolus and one inch above it sweeping around anteriorly in a circle to the middle of the tarsus and then curving downward to the base of the second or third metatarsal (see figure 262), or a vertical incision (see figures 263, 264) is made two and one-half inches long anterior to the external malleolus and extending downward to the inner side of the peroneii tendons. In infantile paralysis where the object of the operation is to give stability at the joint and to interfere as little as possible with the circulation in a patient where the circulation is none too good, the operator prefers the second incision which disturbs the circulation much less. In using this incision it is possible to do the operation in thirteen minutes including very extensive attention to the tibia and both malleoli. The incision in no way hampers the operator as soon as he understands how to remove the astragalus.

FIG. 262.—The usual incision for removal of the astragalus and for operations on the ankle joint. Circular incision.

FIG 263.—Anterior external incision used for astragalectomy in paralytic cases when the sub-periosteal method of elevating the tissues is employed.

The incision extends down to the bone, is made vertically 2½ inches

long anterior to the external malleolus curving slightly anterior to the peroneii tendons, the surgeon using the scalpel. The posterior edge of the incision is retracted slightly (see figure 265). The operator uses an osteotome on the external malleolus to remove the attachment of the

Fig. 264.—Incision anterior to the peroneii tendons in the foot.

Fig. 265.—Retraction of skin and fat.

Fig. 266.—Subperiosteal removal of tissues from the anterior surface of external malleolus.

Fig. 267.—1, Oscalcis. 2, Astragalus. 3, Cuboid.

Fig. 268.—Detaching the periosteum and tissues from the external malleolus, subperiosteally.

lateral ligament subperiosteally (figures 266 to 270). He removes all the tissues subperiosteally from the under side, the back and inner side and the front of the lower fibula for one inch or more (see figure 268). The anterior edge of the incision is next retracted (see figure 269). The osteotome lifts the tissues from the bone well forward. The neck of the astragalus is cut as far forward as possible (figures 270, 271). The bone here is cut completely across. The osteotome is withdrawn

and placed above the astragalus on its tibial articular surface as far inward as possible (figure 271). The foot is adducted for this purpose. The bone is cut vertically down and back leaving a narrow flat disk close to the internal malleolus. There is now beside this disk two other pieces of the astragalus. A large piece close to the external malleolus and a small knob forward of the neck (see figure 271). The outer portion of the astragalus is

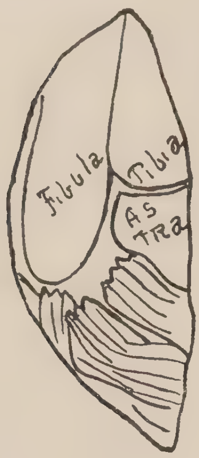

Fig. 269.—Showing relative position of the tibia, fibula and astragalus.

Fig. 270.—Astragalus.

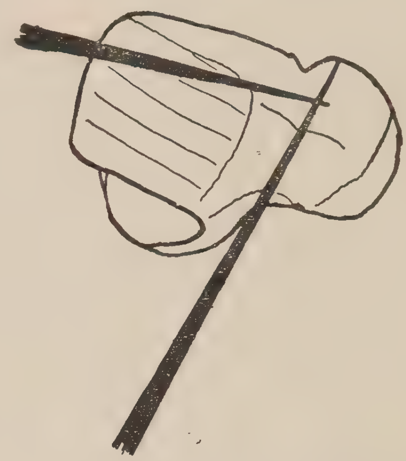

Fig. 271.—Lower line, osteotome cutting the neck of the astragalus, as far forward as possible. Upper line, osteotome cutting the astragalus, from above downward, at the inner side, close to the malleolus.

easily removed and will be found most adherent on its under surface. The operator at this point may dislocate the foot inward as seen in figure 272, or he may remove first the inner disk-like portion of the astragalus from its attachment to the internal malleolus. The lower end of the astragalus beyond the neck is very easy to remove as it has practically no attachments, if the first osteotomy is done forward enough. When the astragalus has been removed completely the foot is displaced inward exposing both malleoli (see figure 272). The tissues are dissected subperiosteally with an osteotome from the posterior surface of the fibula; extending inward, they are removed subperiosteally from the posterior surface of the tibia for an inch upward and from the posterior, anterior, and outer surface of the internal malleolus. If these tissues are not carefully removed the foot will not displace backward as it should and an eversion of the foot will be present which is undesirable in paralytic cases, especially when the muscles that lock the knee are weak or completely paralyzed. The operator replaces the foot and dislocates it backward. He uses his finger through the wound to see if any tissues

Fig. 272.—Displacement of the foot inward, after removal of the astragalus giving full access to the tibia and the malleoli, anteriorly and posteriorly.

resist making a perfect dislocation backward. It should be remembered that the external malleolus is further posterior in the foot than the internal. This relation should to a certain degree be present in order that the foot shall not be everted. If the tissues have not been removed subperiostially from the fibula, tibia and tarsus as described above, it will be necessary to shave off the inner surface of each malleolus and the tarsus against which these malleoli rest. The deep tissues are brought together sealing the bony cavity completely with interrupted chromic catgut sutures number 00, the subcutaneous fat with interrupted chromic catgut sutures number 00, the skin with continuous chromic catgut sutures number 00. A small dressing is placed over the wound consisting of five thicknesses of gauze one inch broad and extending one-half inch beyond either edge of the wound. Sterile sheet wadding is put around the foot over this. The leg is well padded with sheet padding and a plaster of Paris bandage applied from the toes to the groin.

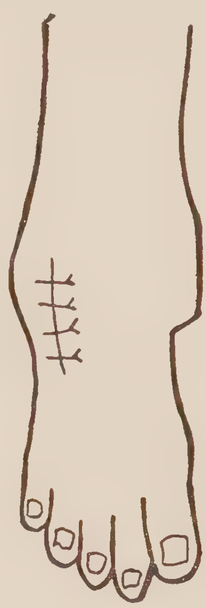

Fig. 273.—Astragalectomy and displacement of the foot backward giving a fullness at the internal malleolus.

In cases of calcaneous, the foot is put up in an equinus position.

In cases without calcaneous deformity, it may be put up in an equinus position for a short time and then brought to a right angle or it may be put up at right angles at the time of the operation. When a tendon transplantation is done to the front of the foot, the foot is put up at right angles.

By dissecting the tissues up subperiosteally they reattach themselves readily and firmly, yet without causing a stiff joint. The ultimate result of astragalectomies with displacement of the foot backward is very good. The patient may expect from one to two-thirds of the normal motion, sometimes more, and absolute lateral stability.

169. After Treatment.—By using the subperiosteal dissection, the after treatment may be the same as that employed for a Potts fracture at the ankle. The patient is allowed to walk with a plaster at the end of six weeks and with a paralytic at the end of four or five months, all apparatus may be omitted. In growing children it is important to broaden the heel or to wear apparatus for a year to prevent the foot turning one way or the other as the bones grow. The shoes should be kept repaired constantly.

An astragalectomy and displacement of the foot backward may be done in connection with transplantation of any strong muscles to take the place of weak ones. The transplantation may be done at the same time as the astragalectomy; the bone operation precedes the transplantation. The peroneii are often used in this way to re-enforce the muscle of the front of the foot or to re-enforce the muscles on the back. Other muscles may be used instead of the peroneii for the same purpose. These

transplantations are done as described elsewhere in these pages; the insertion of the tendons will be further forward at the tarsus on account of the displacement of the foot backward.

The original plaster should not be changed until the sixth week. This assures good displacement of the foot. If the plaster is poorly applied the foot will slip forward. This may be corrected under an anæsthetic, never without, at the end of the first week.

170. Application of Plaster Following Astragalectomy.—As the foot is being placed in a special position it is important that the operator who has manipulated the foot at the time of operation should hold the foot at the time of the application of the plaster, in order to be sure that he is fitting the foot to the tibia as he has planned it. For the same reason some detail as to the method of application of the plaster will not be out of place. The foot having been well protected with well fitting sheet wadding, especially the heel, a cuff of plaster of Paris bandage is put on six or eight layers on the lower end of the tibia and another cuff of about eight layers of plaster around the ball of the foot. When these are hard the operator places the foot in the desired position, manipulates it gently to assure himself that the position is the one he wishes and that the ankle motion is smooth and free. He holds the foot by the cuff of plaster with his right hand and the cuff around the tibia with his left. The assistant finishes the plaster connecting the two cuffs. When this third portion of the plaster has hardened, the position of the foot is fairly assured. A well fitting plaster over the rest of the leg is applied, extending to the groin.

Fig. 274.—Periosteum incised, for the insertion of silk ligaments.

171. Operation for Insertion of Silk Ligaments at the Ankle.—Silk ligaments at the ankle are useful to maintain lateral stability and prevent toe drop in adults and children as a permanent measure in paralytic conditions. They may be used in children for the same purpose as a temporary measure during the recovery of the muscles. They are useful as permanent ligaments to prevent toe drop and to increase the lateral stability when the ankle is not flail, but weak. This is especially the case when the anterior muscles are paralyzed and there is very little power in the posterior muscles. They are useful in this instance in adults and in children. The silk ligament is not of value to maintain lateral stability when opposed to strong muscles, or for a flail ankle. In suitable cases they will make braces unnecessary at the ankle and will give sufficient stability here for weight-bearing. In adults at the ankle they may be applied directly to the bone above and to the bones of the foot below (see figure 279). Where they are to be used temporarily in children, they may also be applied to the bone above and the bone below. When,

however, they are used in children to remain permanently, the upper attachment should be made to the everted edges of the periosteum as de-

FIG. 275. — Incisions for the insertion of silk ligaments in the lower third of the leg and at the tarsus.

FIG. 276.—Method of elevating the edges of the everted periosteum preparatory to the insertion of silk ligaments.

FIG. 277. — The silk quilted up one side and down the other of the everted periosteum; a second strand being tied into the first silk, to give four ends. (See next figure).

scribed below (see figure 277), in order to allow further growth without relative contracture.

172. Silk Ligament Operation at the Ankle. Open Method.—The patient lies on his back, the operator stands to the outer side of the ankle to be operated on.

An incision is made over the anterior and lower third of the tibia two inches long down to the periosteum (see figures 274, 275). This is incised, its edges everted (see figure 276), silk is quilted up one side and down the other (see figure 277). The second piece of silk is tied to the silk in the periosteum giving four strands (figures 278 and 279). The point of insertion in the foot is next selected with a view to good leverage and balance. A curved incision is made over the points in the foot chosen for insertion, one to the outer side, the other to the inner side (see figure 275). The silk is carried subcutaneously from the leg to the foot incision (see

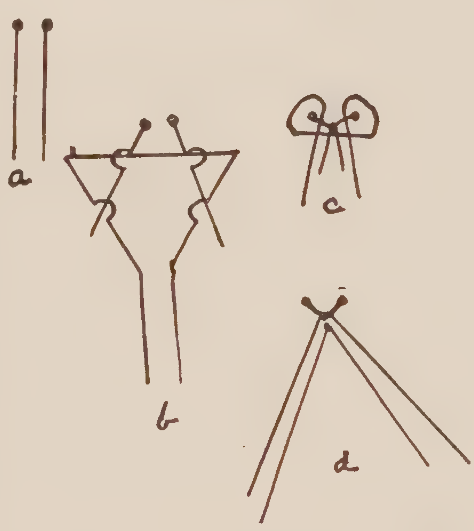

FIG. 278.—Method of tying the first silk and the second silk together to give four strands. The first is inserted into the periosteum. A, First silk strand from the periosteum. B, Second silk strand. C, The first strand tied. D, The second strand tied giving four strands for insertion in the periosteum of the tarsus.

figure 280). At the cuboid and dorsal cuneo-cuboid ligaments, the silk is quilted through the periosteum as described for transplanting the peroneii. On the inner side of the foot a curved incision is made over the scaphoid and internal cuneiform, the silk is carried subcutaneously from the anterior incision in the leg to this incision and there inserted by quilted sutures (figure 232). The knots are pressed down and flattened after three ties. The muscle fibers of the short extensor digitorum are retracted before insertion of the silk in the periosteum and become useful covering for the knot and silk at its insertion on the outer side of the foot. On the inner side the tendons may be used. The deep fascia is brought together over this with interrupted chromic catgut sutures number 00, the subcutaneous tissues with interrupted chromic catgut sutures number 00, the skin with continuous chromic catgut sutures number 00.

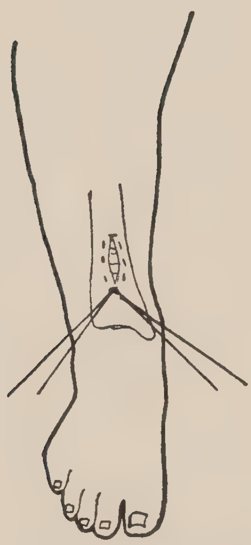

FIG. 279.—Second strand tied to the first, giving four strands, two for each side of the foot.

FIG. 280. — Tendon carrier used to draw the silk down to the tarsus.

FIG. 281.—Periosteal needle, short, round, not brittle, with a large eye; the needle is flattened at the eye.

Before tying these ligaments each silk strand is pulled firmly through its periosteal insertion so that it will firmly hold the foot in very slightly overcorrected position. When the tendo Achilles is resistant or its muscles are strong, it is advisable to stretch the foot well upward and do a tenotomy of the Achilles tendon before inserting the silk. All deformities of the ankle and all restrictions of motion should be overcorrected before inserting the silk;—when the deformities are considerable they should be corrected at a previous operation. The foot should be flexible in all directions at the time of applying the artificial ligaments.

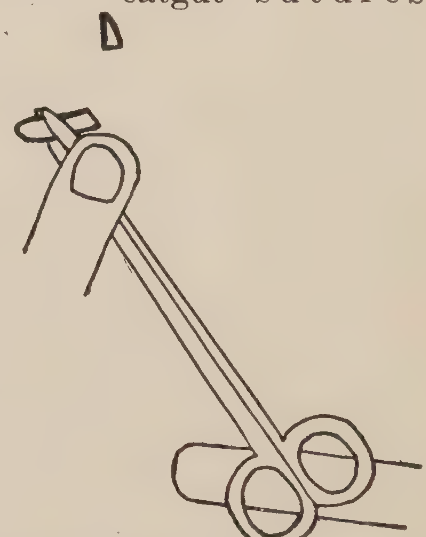

FIG. 282. — Short needle holder, forcing the needle through the periosteum; pressure is applied on the needle holder close to the needle, but no twisting force should be used in order not to break the needle.

The needles used for periosteal insertion are shown in figure 281. In forcing the needle through the periosteum and superficial part of the bone, a heavy hemastatic is very useful. The pressure exerted by the surgeon should

not be applied at the handle of the hemastatic but near the needle with the finger or thumb of the left hand on the hemastatic as shown in figure 282.

173. Silk Ligament Operation.—*Dr. Bradford's subcutaneous method.* Subcutaneous silk ligaments may be applied rapidly with very

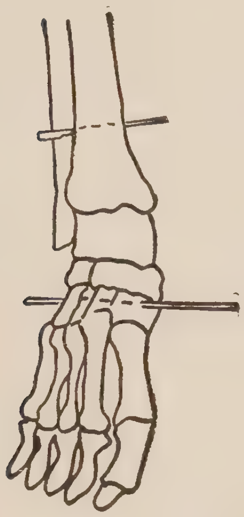

Fig. 283. — Drilling the tibia and tarsus for silk ligaments.

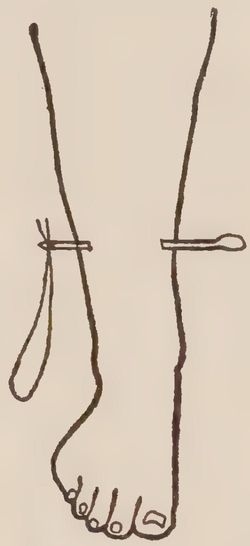

Fig. 284. — Drill with silk wormgut leader inserted into the end of the drill.

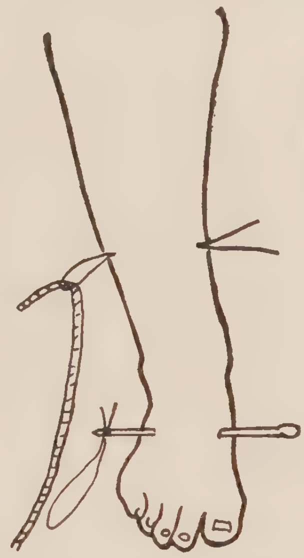

Fig. 285. — Silk wormgut leader used to carry the silk through the tibia; drill inserted through the tarsus. Silk wormgut leader passed through the eye of the drill.

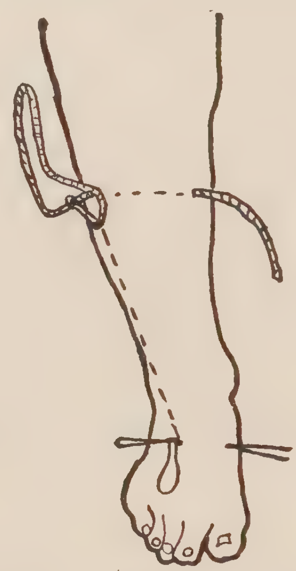

Fig. 286. — Silk passed through the tibia, tendon carrier from the outer side of the foot, to the outer side of the leg, receiving the silk.

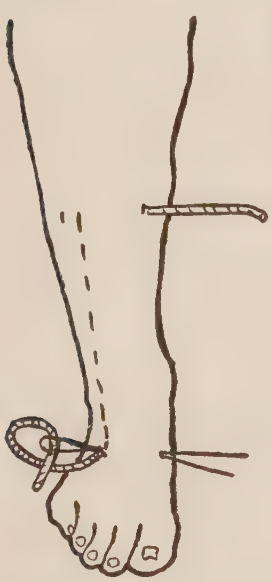

Fig. 287. — Silk through the tibia down to the leg, ready to be drawn through the tarsus by means of a silk wormgut leader.

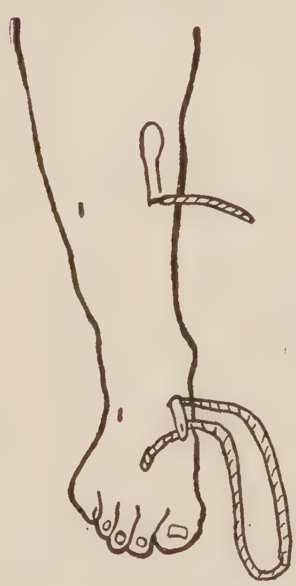

Fig. 288.—Tendon carrier completing the silk insertion.

little disturbance to the tissues. The point in the lower third of the tibia is selected (figure 283), the skin over the bone is slid backward; a drill with an eye in its end is passed through the skin and tibia (figure 284); as it protrudes from the bone on the other side of the leg, the skin is slid forward and the drill pushed through it. In this way the hole in the skin and in the bone will be out of line. The two ends of a piece of silk wormgut are passed through the eyes in the drill and withdrawn with it (figure 285). The loop in the silkworm gut is left protruding on one side of the leg, the two ends at the other side. The exit of the drill in the skin is made at a different level to the bone exit. This is done by pulling the skin to one side of the bone before the drill perforates it as described above. The tarsal bones are drilled in a similar way (figures 283 and 285). As the drill is withdrawn a guide of double silkworm gut is pulled through the bone

so that the loop protrudes at one side of the foot and the two ends protrude at the other side. A double strand of heavy braided silk number 16 or 18 is carried through the tibia bones by means of the silkworm gut guide. A carrier is introduced at the skin puncture at the side of the tibia (see figure 286). This guide is carried up subcutaneously and brought out through the skin hole above (figure 286). The silk is passed through the eye of the carrier and drawn downward (figure 287). This silk is next passed through the loop of the silkworm gut and drawn through the tarsus. The carrier is next inserted to the inner side of the tibia through the skin and carried downward subcutaneously so that it protrudes below at the midtarsal region. The silk here is passed through the eye of the carrier and drawn upward subcutaneously so that both ends of the silk now protrude from the same hole above (figures 288, 289). The ligaments are drawn tight and the foot elevated. The silk is then tied and the ends cut; the skin is drawn outward over the knot which now slides through the tissues and lies close to the bone. The skin perforation being at a different level from that of the drill hole in

FIG. 289.—Silk just before tying.

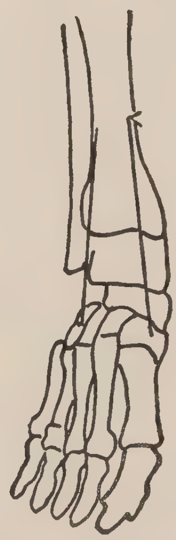

FIG. 290.—Silk ligaments. Silk inserted from the tibia to the tarsus to prevent toe drop.

FIG. 291.—Tendon of the peroneus longus displaced forward, and sutured in a groove in the bone.

the bone, no sutures are necessary. The foot should be held in a very slight overcorrection by the silk ligament. Plaster is applied holding the foot so that no strain comes on the silk ligament.

174. Tendon Fixation.—In the use of tendon fixation, advocated and improved by Dr. Galli, slight overcorrection of the deformity should be made. Either the whole of the tendon may be cut away above and the distal end put in a groove in the bone to grow and be nourished there by the bone and periosteum to which it becomes attached, or instead of using the whole of the tendon the tendon is split and one-half left intact; the other half cut and its distal end used for tendon fixation. In this way any tendency of the muscle to regenerate will be safeguarded.

This method of tendon fixation is not recommended where there is extreme deformity or where the tendon fixation would be opposed to strong muscles or for total flail conditions of the ankle.

175. Tendon Fixation for Varus. *Dr. Galli's method.* When the peroneii are paralyzed and tendon fixation is decided upon, a vertical incision is made on the outer aspect of the lower end of the fibula. The skin is retracted exposing the fibula three inches from the tip of the bone. "With a periosteal elevator, the periosteum is raised one-eighth of an inch or more on either side of the incision and in the case of the epiphysis or epiphyseal cartilage, the perichondrium and a flake of cartilage are raised with a knife. . . ." With a gouge a groove is made two and one-half inches long and one-eighth of an inch wide, to receive the peroneii tendons. The tendon, denuded of its tendon sheath, is placed in the groove. The tendon does not attach itself to the bone but slides if the sheath is not removed. The foot is brought around in the position desired, the tendon pulled tight and fastened to the periosteum by a silk suture. It is also fastened below by a silk suture which prevents it from slipping; its upper end may be turned down. The peroneus longus is displaced forward before being placed in this groove on the front of the fibula (see figure 291). The peroneus brevis is allowed to remain under the external malleolus and placed in a groove on the posterior aspect of the fibula (see figure 292). The periosteum is elevated, a groove two and one-half inches long and an eighth of an inch wide is made on the posterior aspect of the fibula to receive this tendon. The tendon is denuded of its sheath, placed in the groove, the periosteum brought together over it, the tendon doubled over at the top, having first been pulled tightly and sutured at the upper end of the tunnel and at the lower end of the tunnel with one or two silk sutures.

FIG. 292. — Tendon of the peroneius brevis inserted in a groove in the bone posteriorly. The peroneus longus displaced forward and inserted in a groove in the bone.

176. Tendon Fixation for Valgus.—*Dr. Galli's method.* Where there is marked valgus and the tibialis anticus is completely paralyzed, an incision is made on the anterior and inner aspect of the lower end of the tibia down to the tibialis anticus. A groove is made in the lower end of the tibia similar to that in the fibula (see figures 291 and 292), one-eighth of an inch wide and two and one-half inches long. The tendon of the tibialis anticus is denuded of its sheath, and drawn into the groove. The periosteum is brought together over this, the tendon is turned over at the top and sutured with one or more silk sutures, at the upper and lower ends of the tunnel. A tunnel should

be made in a similar way for the tibialis posticus on the inner side of the tibia.

177. Tendon Fixation for Calcaneous.—*Dr. Galli's method.* In cases of calcaneous, an incision is made along the whole length of the tendo Achilles. The sheath is split throughout the length of the incision and the tendon exposed. It is freed from its attachments to the sheath and retracted inward so as to expose the fibrinous covering of the deep muscles of the leg. A vertical incision is made through this sheath (which is the intermuscular septum between the deep and superficial layers of the flexor muscles of the leg) and the long flexòr longus hallucis comes into view. This muscle is then retracted inward, exposing the posterior surface of the shaft and lower extremity of the tibia. About three inches of the tibia is exposed. A vertical incision is made through the periosteum. A large gouge is used to open up the medullary cavity of the bone. This trough receives the tendo Achilles and the periosteum is closed in over it. If the leg is short the patient is put up in slight equinus, if not the tendon is held with the foot at right angles. In some cases a tendon fixation of one-half the tendon has been used and the other half allowed to remain attached to its muscle. In this way only the deforming part of the motion is limited. Fixation in plaster of Paris is used as described for tendon transplantation.

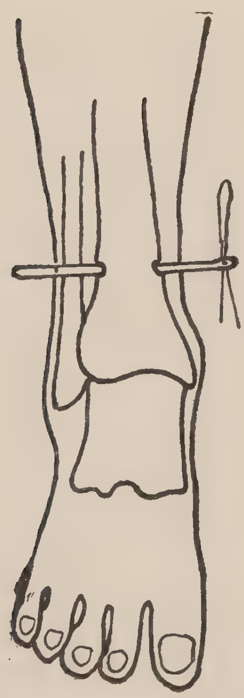

Fig. 293. — Tibia drilled, silk wormgut leader placed in eye of drill.

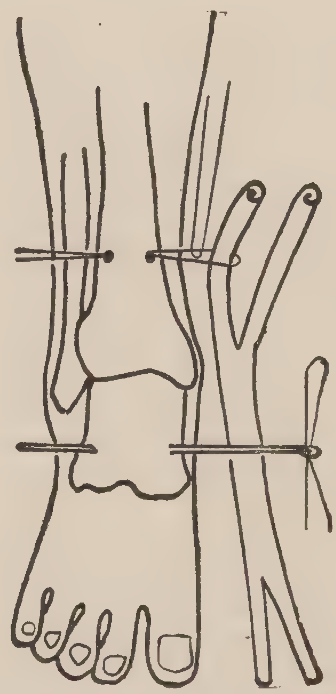

Fig. 294.—Silk wormgut leader loop ready to draw a second silk wormgut leader through the tibia, and with it the rolled end of the fascia. The drill is passed through the tarsus and receives a silk wormgut leader here.

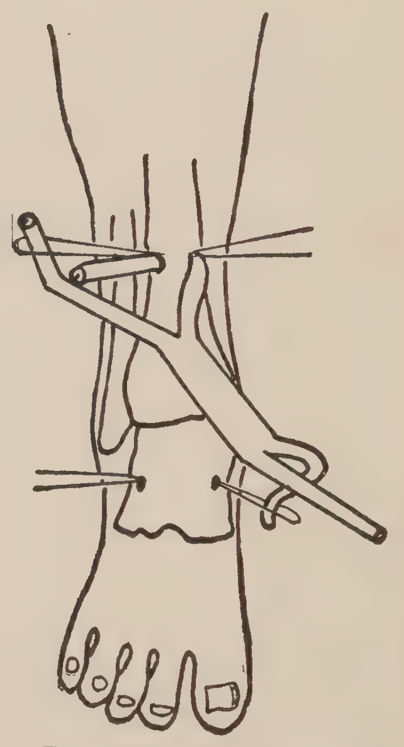

Fig. 295.—The fascia is drawn through the bone by the first silk wormgut leader and with it the second silk wormgut guide which is used to draw the second end of the fascia through the tibia.

178. Fascia Transplantation for Toe Drop.—The patient lies on his back, the operator stands on the same side of the table as the leg to be operated on. An incision is made three inches long over the front of the lower third of the tibia down to the bone, the tissues are retracted, the bone drilled with a large drill made with an eye in its end. A double strand of silkworm gut is passed through the drill to act as a guide (see Operation for Silk Ligament and figure 293). A second incision is made longitudinally and centrally over the midtarsal region and carried down to the bone; the edges are retracted and the bone exposed with its overlying periosteum.

An incision is made five or six inches long in the unparalyzed leg on the outer side of the middle of the thigh through the skin and fat down to the fascia lata. A piece of fascia may be removed much longer and broader than the incision by retracting up, then down and then laterally. The amount selected should be estimated by measuring with a probe. The fascia removed should be not less than two inches wider and two inches longer than the length necessary to go through both bone holes and cover the distance between. The fascia is slit at each end (see figure 294), the ends are then rolled. The rolling makes the fascia tougher, the upper ends are drawn through the hole drilled in the tibia, then overlapped and sutured with interrupted chromic catgut sutures number 00 (see figure 295). The fascia is carried in a subcutaneous tunnel made just below the fat to the lower incision in the foot (see figure 296). Or it is sutured to the periosteum by quilted silk sutures (see figure 297), or the bones of the foot may be drilled and the fascia inserted in the same way as in the tibia.

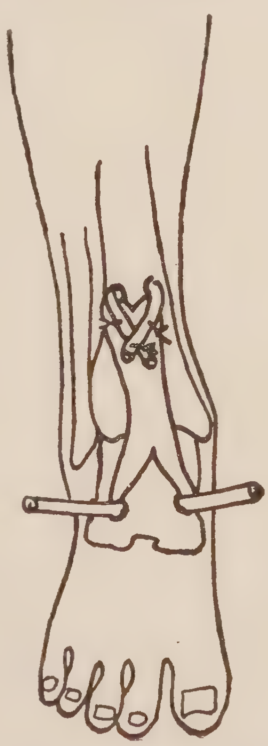

Fig. 296. — Both upper ends of the fascia are passed through the tibia and sutured; both lower ends of the fascia are passed through the tarsus ready for suture.

Fig. 297. — A method of suturing the fascia with silk to the tibia and to the tarsus by quilted sutures.

Fig. 298. — The fascia sutured to the tibia and to the tarsus.

If the operator prefers, he may slit the periosteum of the tibia longitu-

dinally, its edges then everted (see figures 297 to 299), and the fascia tucked under the periosteum and stitched here with silk number twelve or number fourteen. At the foot two grooves may be made in the bone with an osteotome, the ends of the fascia tucked each in his groove and the periosteum drawn tightly over the stitches extending through the transplanted fascia. Before attaching the fascia firmly the foot should be brought to a position of fifteen or twenty degrees of dorsal flexion and be held here by the fascia. The deep tissues are brought together with interrupted chromic catgut sutures number 00, the skin with continuous chromic catgut sutures number 00. A dressing of four thicknesses of gauze, extending one-half an inch beyond is placed over the wound, then sterile sheet wadding. A plaster of Paris bandage is applied over this from the toes to the groin, care being taken to protect the heel to prevent pressure and tension on the transplanted fascia. The plaster is split on either side to allow removal of the front half for inspection of the incision. The plaster remains for eight weeks, the patient being allowed to walk with the plaster a little after the first six weeks; when walking becomes easy a short caliper with a double stop at the ankle is used during the day and the plaster at night to prevent toe drop for one year at least.

Fig. 299.—Incisions closed.

179. Arthrodesis for Flail Condition of the Ankle.—For arthrodesis at the ankle an incision is made starting one-half an inch posterior to the external malleolus and one inch above. This sweeps around over the fibula and forward to the middle of the front of the foot and then down to the base of the second and third metatarsal. The soft tissues are retracted and the periosteum removed from the external malleolus with its ligaments with an osteotome. The foot is dislocated outward, a thin layer of bone is cut from the top of the tibia and the internal aspects of both malleoli are likewise denuded of periosteum. The surface of the astragalus should fit the bony surface of the tibia and fibula, and wherever they come in contact the bone should be exposed. The foot is replaced and the bones held together by heavy chromic catgut sutures number 1 or kangaroo tendon sutures. The deep tissues are brought together with interrupted chromic catgut sutures number 00, the superficial fat with interrupted chromic catgut sutures number 00, the skin with continuous chromic catgut. A very small gauze dressing is applied over the incision; sterile sheet wadding over this. A plaster of Paris bandage is applied from the toes to the groin with the knee slightly bent, the foot being held at right angles. This plaster should be worn without weight bearing for about six weeks; after that a light plaster applied from the knee downward and the patient en-

couraged to walk. At the end of ten weeks he may walk without support.

There are so many better operations than arthrodesis at the ankle that there are very few conditions for which it may be recommended. A totally flail ankle, known as "dangel foot" can be made serviceable with excellent lateral stability and yet up and down motion by means of an astragalectomy and displacement of the foot backward which is preferable to any operation which would stiffen the joint. Moreover, in cases where the joint is not extremely loose, silk ligaments or ligaments made out of the tendons around the ankle as advocated by Dr. Galli, are distinctly preferable to a stiff ankle from arthrodesis. In walking, arthrodesis causes an awkward motion of the foot, the leg being held outwardly rotated. When the ankle is perfectly stiff by an arthrodesis, the patient walks as if he had a painful flat foot. As the front of the foot will not come up, the toe must be everted in order to make walking easy.

CHAPTER IV

INCISION, PUNCTURE AND ARTHROTOMY

180. Arthrotomy.—A knowledge of the important routes of approach to the joints will facilitate any joint exploration, the removal of foreign bodies, the repair of traumatic conditions, the adjustment of difficult fractures, the reduction of old and difficult dislocations, the mobilization of joints where motion is partially or totally lost, and stiffening the joint as in certain paralytic conditions, to relieving and thoroughly draining suppurative conditions; a knowledge of the important routes of approach to the joint is very important. For each case, the operator will select the incision best suited for the individual condition. Each joint will be considered separately in other chapters.

In all operations on the joints, the incision should be made down to the synovial membrane and made large enough before opening the synovial cavity. All bleeding should be stopped and the synovial membrane carefully opened. The joint structures should be tampered with as little as possible, the synovial membrane brought together carefully and the layers over it closed in order not to disturb the function of the peri-articular tissues. Unnecessary separation of the tissue layers is to be avoided. Tendons should be left in their sheath. Any ligaments that must be cut should be loosened periostically, in order that they may be readily replaced. Early motion should be the rule, gentle at first, and gradually increased. Joint operations should never be hastily considered and should be avoided by anyone not familiar with the best surgical technique.

Fig. 300.—Anterior external incision. Posterior external incision.

181. Anterior External Incision (figure 300).—At the ankle a curved incision may be made starting two and one-half inches above the external malleolus extending along the anterior border of the fibula, curving downward and forward just above the peroneii tendons to the cuboid. The tibia-tarsal joint line is a little over an inch above the tip of the fibula.

182. Posterior External Incision (figure 300).—An external incision may be made halfway between the external malleolus and the outer edge of the tendo Achilles, starting two and one-half inches above the malleolus extending downward parallel to the fibula and curving forward three-fourths of an inch below the tip of the external malleolus.

183. Anterior Internal Incision (figure 301).—An incision may be made along the anterior border of the tibia starting two inches above the internal malleolus. This incision is carried downward and forward to the tubercle of the scaphoid. Any of these incisions may be carried further forward for operation on the tarsus.

FIG. 301.—Anterior internal incision. Posterior internal incision.

184. Posterior Internal Incision (figure 301).—An internal incision may be made halfway between the tendo Achilles and the internal malleolus starting two inches above it and extending downward and curving forward one inch below the internal malleolus. These incisions will give access to the os-calcis and the posterior part of the ankle joint. An incision close to the peroneii or posterior tibial tendons and very close to the bone at the malleolus is very undesirable as the scar often becomes adherent to the bone which gives discomfort and pain later on. The two posterior incisions may be joined by an incision continued around over the os-calcis and extending from three-fourths of an inch below the external to three-fourths of an inch below the internal malleolus. This may be done without carrying the lateral incisions upward or in addition to the lateral incisions extended upward. In view of the fact that the two posterior incisions above described give ready access when used together to the os-calcis in cases of fracture or of extensive disease, it is better not to use the horizontal incision over the os-calcis as the scar is often painful later on and it rubs against the shoe. For fractures these incisions give ready access to any part of the tissues. For disease of the os-calcis they should be combined; the two posterior are sufficient unless the disease extends far forward and involves the astragalus. In this instance an anterior median incision with the two posterior will give all the room that is necessary for removal of bone or sequestra and for good drainage.

FIG. 302. — Anterior median incision.

185. Anterior Median Incision (see figure 302).—An interior median incision is made two inches above the joint line and extends vertically downward over the midtarsus just external to the extensor of the great toe to the base of the third metatarsal. It may be made over the middle or outer third of the foot. Plantar incisions should be avoided; the incision to the sole should be at one or both sides of the foot; there are of course exceptional cases of foreign bodies.

186. Circular Incision for the Exposure of the Ankle Joint. (See Figs. 303 and 304.)—An incision is made one inch above the external malleolus starting halfway between the fibula and the tendo Achilles and extending forward and slightly downward to the front and middle of the tarsus, then curving directly downward to the base or middle of the third metatarsal.

The tissues may be lifted subperiosteally, the tendons retracted in the tissues, allowing the edges of the incision to be raised for an inch either way, the ligaments about the external malleolus are separated off the anterior internal and posterior as well as the external surface of the fibula, allowing the foot to be dislocated inward as shown in figure 304.

Fig. 303.—Incision for removal of the astragalus or for a complete inspection of the ankle joint by displacing the foot outward. (See figure 304.)

Fig. 304.—Displacement of the foot outward after incision for inspection of the ankle. (See figure 303).

This gives an excellent view of the tibio tarsal joint, the astragalus and the upper portion of the tarsus. It is usually not necessary to cut the tendons to dislocate the foot. The foot should be carefully replaced and the deep tissues as well as the skin sutured. The external ligaments if detached subperiosteally from the fibula will reunite without suture. It will be remembered that they are lifted from the outer side of the malleolus with the skin and fat and periosteum. After operation the foot is held in plaster dorsally flexed thirty degrees.

187. Arthrotomy for Fractures About the Joints.—The necessity of immediate operation in fractures about the joints depends, as in other fractures, on the acuteness of the local and general reaction. When these do not contra indicate immediate operation, certain fractures about the joints may require treatment by the open method. Among these are fractures of the patella, fractures of the olecranon and certain fractures of the surgical neck of the humerus and certain fractures of the neck of the femur, all compound fractures, even when the protrusion of the bone has been extremely slight, all fractures that cannot be reduced by manipulation or in which the correction cannot be maintained or where apposition is impossible, many fractures combined with dislocation, articular fractures with pieces locking or limiting the joint action.

Where there is a great deal of trauma and in multiple fractures and in cases where there is a great deal of shock, all that can be done is to immobilize the parts until a favorable time for operation. In selecting a suitable time for operation, when it is found necessary to operate on a fracture if there is no immediate contra indication, the sooner it is done the better. Where there is extreme swelling the surgeon should always wait. All cases should be operated on that show no union after three months of good treatment.

Methods of treating the individual fracture cannot be considered in a limited space like this. The writer has described the routes of approach to the different joints and the technique of these. This will enable the surgeon from his knowledge of fractures to select the route best adapted for the individual treatment required and when necessary two or more incisions may be used. A knowledge of the technique will enable the surgeon to work rapidly in reaching the fracture on which he expects to spend time.

188.—The bones of the leg are readily reached and cut with an osteotome in the case of deformity from fractures. The fresh fractures that require open operation are also readily reached. It is important in fractures about the ankle to note the position of the foot with reference to the patella and anterior spine. The great toe should be in a line with the inner border of the patella and the anterior superior spine. The bone should be otherwise aligned and the foot not allowed to drop back. If this takes place the patient loses the dorsal motion of the foot, so important for any form of activity. Anterior bowing at the point of fracture is apt to take place and evertion of the foot. These must be prevented especially in low fractures of both bones. If the malleoli are fractured, the foot will displace backward. To prevent this, the foot should be dorsally flexed as described by Cotton. In almost all ankle fractures, the foot should be dorsally flexed from twenty to forty-five degrees, depending on the case. In bowing and deformity from old fractures after cutting the bone, a tenotomy of the tendo Achilles is usually necesssary to allow free overcorrection of the fracture.

189. A Method of Treating Overlapping Fractures.—Where the bones overlap, an excellent method of treatment is one suggested to the writer many years ago by Dr. Edward Martin of Philadelphia. In the operation when the surgeon has reached the fracture the ends are freed. A tough tape or webbing is used ten or twelve feet long, sterilized. The two ends of the tape are tied together, a loop of the tape is placed over the distal end of the bone. The other end of the tape is thrown over the foot of the operating table, a thirty-five pound weight is attached to this by an assistant. In about five minutes the bones will be found to be separated at least one inch. The weight is then held up by a nonsterile assistant, the tape taken off of the end of the bone and clamped to the sheet on the operating table, so that it will not slip away while the surgeon works on the fracture. When the muscles are in fairly

good tone or the overlapping of bone has been great, it will be found that the bones will overlap again in four or five minutes. A reapplication of the tape will separate the bones again for the same length of time. The end of the lower bone should not be cut or freshened until all other procedures are done which require separation of the bones. When these have all been done the end of the bone over which the tape has been placed is freshened. After this the tape should not be placed on the end of the bone, unless it is very necessary, but the two ends allowed to come together and held by a clamp until the operation is complete.

Very bad overlapping fractures have been treated in this way in fresh cases without the necessity of shortening the bone. In old fractures no more bone need be removed than is required by the conical condition of the ends of the bone.

190. Fractures of Long Standing Still Ununited or United with Deformity, Preventing Function.—In fractures of long standing where there is a mild infection, conservative treatment should be tried first. When this has been tried free drainage should be established and at the same time the ends of the bone freshened up slightly. Unless the infection is marked, in many of these cases when the suppuration disappears, union has also taken place. In any case where there has been infection, no plastic operation should be used until the infection has been entirely absent for at least nine months—a year is safer. Where the infection is very mild and of long standing, during the process of treatment the patient may be allowed to walk on the other leg if the local reaction is not too great. Sometimes he may walk a little on the affected leg. It is of advantage in certain cases to use a Thomas splint to take some of the weight off of the affected leg, the patient being allowed to bear weight on the ball of the foot, the splint taking all the weight off of the heel. Where the x-ray shows conical ends of the bone it is practically useless to expect union without surgical interference.

191. Tapping the Ankle.—The most scrupulous aseptic precautions are necessary both as to the preparation and the protection of the field of operation.

When there is effusion the joint is readily reached with a trocar either anterior to the external or internal malleolus and just posterior to the tendon sheaths. The skin is drawn to the side so that the hole in the skin and muscle will be out of line when the needle is removed. If fluid is to be drawn, and other solutions are to replace it, the amounts should be carefully measured. Two good graduated metal syringes are very useful. All of their parts should be tested beforehand. The trocar is made to enter the joint and then is connected with the syringe. As little air as possible should enter the joint. The trocar should be of large diameter as the fluid may be thick or flaky. When the patient is not anæsthetized for the operation it is often well to have a short flexible tube connect the trocar with the syringe. This should be fastened

at both ends by silk ties so that it will not leak easily when pressure or suction is used. If the joint is to be washed out a definite amount of fluid is injected and the return measured in a sterilized measuring glass.

The tibio-tarsal joint is about one and one-fourth inches above the external malleolus.

Dr. Murphy uses a formalin glycerine solution as follows:—

Liquor formaldehyde, 2% in glycerine.

About ten drops of formaldehyde to each ounce of glycerine.

This acts very well in infectious synovitis.

But it should not be used in arthritis deformans nor in old chronic arthritis.

The solution should be prepared twenty-four hours before it is used (Murphy). The tapping may be done with ethyl chlorid or novocaine adreneline solution, 1%.

CHAPTER V

OPERATIVE TREATMENT IN CASES OF JOINT ANKYLOSIS

192. Arthroplasty for Ankylosis.—Ankylosis may be bony, cartilaginous or fibrinous, it may be periarticular, ligamentous and capsular, or extra articular, that is, skin scars, tendons, fascia, nerves and arteries.

The form of ankylosis that exists will determine the treatment. A partial ankylosis at certain points had better not be treated by an arthroplasty.

Age must be considered, also the general condition of the patient. When the ankylosis is bony, cartilaginous or fibrinous, arthroplasty is indicated. When the condition is periarticular or extra articular, it may be treated by capsulotomy, tendon elongation, excision of exostoses, etc.

Dr. Murphy lays stress on the following points:—The principles of asepsis to the finest detail are absolutely essential. One not familiar with the best surgical technique should avoid arthroplastic operations. The exposure of the joint must be generous and careful. The excision of the ankylosis must be complete. The contracted capsular ligaments and soft parts must be freed and if necessary lengthened. The normal contour of the joint should be restored as near as possible. The operator should obtain a hyper-mobilization of the joint. The joint should be re-shaped to give stability. The inter-position of material to prevent reunion of the bone is necessary. The principle is to separate the bones and to interpose between them material to prevent ankylosis. The best material for this purpose is the human pedicle, composed of fat, muscle, fascia, or a combination of these.

When this is not possible, a transplantation is made of fat and fascia from the trochanter bursa region or from the fascia lata.

Material such as ivory, celluloid, silver are not good. Materials that will not absorb or that absorb too slowly are not desirable.

During the operation the soft parts should be freely liberated. Attach the interposing flap to one bone only and cover it completely. Early motion, that is, at the end of five to seven days is necessary with or without gas or gas oxygen.

Dr. Murphy records failures in arthroplasty as due to first, insufficient and defective exsection of the capsule and ligaments, second, insufficient interposition of fat and fascia between the separated bony surfaces, third, infection, fourth, the sensitiveness of pain on motion after operation.

Cases of primary tuberculosis and cases of recent infection that have

subsided are not suitable cases for arthroplasty. In operation, in addition to the usual protection of the field of operation, after the skin and fat have been incised, towels should be clamped to the edges of the skin as an extra protection.

193. Tibia-Tarsal Arthroplasty.—An incision is made one inch above the external malleolus starting halfway between the fibula and the tendo Achilles extending forward and slightly downward to the front and middle of the tarsus, then curving directly downward to the base or middle of the third metatarsal.

The tissues may be lifted subperiosteally, allowing the edges of the incision to be raised an inch either way. The tendons are retracted with the tissues. The ligaments about the external malleolus are separated off the anterior internal and posterior as well as the external surface of the fibula, the joint line is made with a chisel or osteotome allowing the foot to be dislocated inward as shown in figure 304, the periosteum is peeled back from the tibia for one inch anteriorly and posteriorly. A piece of fascia three by five inches or larger is removed from the outer surface of the fascia lata. This is placed over the front, the under side and the posterior surface of the tibia. When the fascia is sutured in place the foot is replaced. The deep tissues as well as the skin and fat are brought together with sutures. As the periosteum was raised from the external malleolus, one inch above its tip and stripped downward with the external lateral ligament, the latter will unite without suture. A carefully applied plaster of Paris bandage is used holding the foot dorsally flexed thirty degrees.

CHAPTER VI

OPERATIONS IN SUPPURATIVE CONDITIONS

194. Suppurative Joint Conditions about the Ankle. (See Carrell-Dakin technique, section 323.)—In suppurative conditions about the ankle joint, openings and counter openings should be used in severe cases; in milder conditions a single incision is rarely sufficient. One of the lateral incisions should be used as indicated by the swelling. When the focus is located another incision is made on the opposite side of the joint or anteriorly or both, as the case requires.

195. Disease of the Os-calcis and Tarsal Bones.—In disease of the os-calcis and tarsal bones when the condition is acute, drainage with opening of the bone is indicated. When the focus is located, the foot should be drained on both sides and if necessary anteriorly. If the disease is sub-acute and of long standing and has not yielded to conservative methods or to through drainage, the focus as indicated by an x-ray should be chiselled out by cutting in the good bone around the focus and removing the whole disease. Drainage is established on both sides and anteriorly in some cases, if necessary. The cavities are irrigated with salt solution and wiped out with gauze strips. The soft tissues are gaped with gauze in the corners to keep them wide, tubes are placed extending to the cavities.

The foot is held in a plaster with plaster ropes to allow large windows for dressing (figures 451 to 456). The method of application should be carefully planned to give immobilization without having the plaster heavy. The wicks and tubes are shortened after the tenth day, then removed. By this method no further wicks need be applied as the wounds made large in the first place become round in shape and close slowly.

The whole of the os-calcis or any other bones of the tarsus may be removed leaving the periosteum and a small shell of bone. The whole will reform in about six months, allowing some weight-bearing with the plaster. When weight-bearing is painless, the plaster is gradually omitted. A small sinus may last for six months more, sometimes it will close in three months. The foul original condition and the pain will be eliminated by the operation and a good foot for function will result ultimately.

196. Operations on the Metatarsal and Phalangeal Bones and Joints. (See Fig. 305.)—To reach the joints or small bones of the *foot* a dorsal incision or two dorsal incisions may be made between the line of the artery and the line of the tendon. The skin incision should be made down to the bone without separating the fat and other tissues.

In other words, the periosteum is raised from the bone without exposing the structures between it and the skin. This raising of the periosteum is made with a long handled, very small osteotome, the osteotome being used as soon as the knife has reached the bone. When the periosteum is raised, small dull hooks or retractors are then used to hold the tissues and expose the bone or joint. In a similar manner the *metatarsals* are exposed.

197. Operation in Tuberculosis of the Tarsus.—An esmark rubber bandage is applied to the foot and leg up to the middle of the calf and a tourniquet is applied above this.

FIG. 305. — Incisions for reaching the bones and joints of the foot. Metatarsal and phalangeal incisions.

In tuberculosis of the os-calcis, a posterior lateral incision is made on either side of the os-calcis one-half inch posterior to each malleolus extending down and curving forward. The incision is carried down to the bone; the tissues are dissected up subperiosteally. The incisions are retracted well, exposing the bone. The diseased bone will come into view, a chisel is used in the healthy bone around it, chiselling away a small portion of the healthy bone around the focus. The bone is chiselled away and the diseased bone can be removed readily. When all the disease has been removed in this way by cutting through the healthy bone, the cavity is wiped out with strips of gauze until they come out perfectly clean. It is then irrigated with salt solution, then wiped out again with long strips of gauze. As a rule it is better not to use a curette in bone disease. The edges of the wound are gaped by rolled gauze sponges. The foot is held in slight dorsal flexion by means of a plaster of Paris bandage, extending from the toes to the knee. In extensive cases, a plaster should extend to the groin. The plaster is applied with plaster ropes (see figures 451 to 456) so that the dressing may be done without soiling the plaster or interfering with the position of the foot. At the end of six weeks the plaster is changed, and a great deal of new bone will have formed.

In ten weeks there will be almost no discharge. A small sinus may persist for six months or longer. The pain and foul condition of the wound will disappear usually ten to fourteen days after the operation. The patient is up in three weeks and may walk on the foot with the plaster and crutches after twelve weeks.

OPERATION IN TUBERCULOSIS OF THE BONE

In tuberculosis of the bone in the foot and hand with or without abscess, operation on the diseased bone is to be avoided. When conservative methods have failed complete drainage and counter

drainage is indicated with an opening made in the bone. But large abscesses will often absorb and give less constitutional symptoms when allowed to absorb than when the infection becomes mixed following operative procedures. When it is necessary to open these abscesses because they are about to break or because of the condition of the patient they should have drainage and counter drainage, the cavities wiped out and washed out and again wiped out. After this tubes are placed to all dependent parts of the abscess cavity and gauze used to gap the angles of the incision. These tubes and gauze wicks are left in place ten days and then gradually shortened, no injection should be used, nor any irrigation after operation. The reapplication of wicks will probably be unnecessary if the incisions are large enough.

In tuberculosis of the bone it is rarely necessary to do more than drain and counter drain the abscesses, sometimes drain the bone cavity.

It is better not to attempt to excise the disease excepting in extremely severe cases. The small focus will do better without being excised, the large ones may come to extensive operation and excision. See section 212.

In draining a psoas abscess it is better in every case to drain the lumbar region as well as the abdomen or the groin. When the abdomen or groin is opened at the point of swelling, a large urethral sound is carefully opened here and made to protrude behind, the operator cuts down on the sound behind, giving posterior drainage.

The rule for a posterior counter opening in a psoas abscess should always be followed; the duration is shorter and the drainage more satisfactory.

198. Osteomyelitis.—In osteomyelitis an operation should be done as early as possible after making the diagnosis. In sub-acute cases, incision and drainage are all that is necessary. Whenever incising for abscess all the pockets should be opened and if the abscess is large, counter incisions are made at dependent portions. The pus pocket should be opened freely, wiped out with gauze, irrigated and wiped out again with gauze. Curetting should be avoided excepting for the removal of sinuses in the skin and in cases of sinuses it is often better to excise them. Perforated rubber tubing should be placed to drain the deepest portions of the pockets. The skin, fat and superficial muscle layers should be made to gap by means of gauze drains. At the end of ten days the gauze is removed and the tubes shortened. The tubes are gradually drawn out a little each day or two until not used. This method makes the repeated reapplication of drains and wicks unnecessary as the wound will gap of itself and close from the bottom if the surgeon has been careful to make large incisions.

Where the periosteum is found destroyed or the pus under the perios-

teal layer, the bone should be opened by means of a large drill or a small gouge. Where this is necessary, the incisions should be large and the counter incision should be made on the other side of the bone with a hole made in the bone a little above or a little below the hole on the opposite side (figure 66). These holes in the bone should open up the medullary cavity. They should alternate on one side and the other as far up and down as the disease is suspected. When the abscess is very great and the bone involvement is large a number of good sized holes should be made with a Burr drill or a curved gouge on both sides of the bone as shown in figure 67. The wound should be gaped widely;—the skin, fat and superficial muscle held open by large gauze drains. The tubes should reach from the surface to the deepest portions of the abscess cavity. Splints should always be applied to immobilize the limb. They should be placed so that they will not interfere with the dressing. In some instances it is better to apply plaster with large windows and ropes to give stability as shown in figures 451 to 456. The dressing should be done every day or twice a day, depending on the foul condition of the discharge. If the odor is excessive, chlorinated soda dressing should be used diluted, using it $^1/_2$, $^1/_3$ or $^1/_4$ the U. S. P. strength. The gauze drains should be left for at least ten days without being disturbed. When removed granulations will be formed under them in such a way as to keep the wound open without applying the drains. Irrigation may be used at the time of operation and the wound thoroughly wiped out with gauze afterward. No irrigation or probing or application of wicks will be necessary if the first drains are left in long enough. After the first ten days the tubes are shortened up gradually until they are not needed.

In severe cases where the patient is unconscious or delirious, the bone should always be opened, three or four holes on either side made with a good sized Burr drill or a gauge. In no case should the incision be made only on one side of the leg in severe cases. No tight packing should be used as this interferes with good drainage. Where sequestra have formed they should be removed. An x-ray should be taken whenever possible to determine the position of the disease, (unless the case is urgent and an immediate x-ray is not obtainable).

In cases of long standing that are sub-acute at the first examination, where the bone is riddled with holes over an extremely long area, it is impossible often to remove the dead bone satisfactorily without removing all the bone. In these cases free incision down to the bone with frequent openings into the bone as described above, will allow the septic process to run its course and the sequestra to gradually separate. We have had some cases in which the lower third of both femora were riddled with holes and full of sequestra, the patient being in no condition for extensive operation, and yet not very ill. In these cases, however, if the surgeon has seen the patient in time an early operation would have prevented this extreme condition.

199. The Carrell-Dakin Method of Treating Pus Cavities.—Much may be expected from this method in the future treatment of suppurative conditions. See section 323.

Sometimes it is necessary to close a large bone cavity which will not heal over. Where the process is distinctly septic no plastic operation should be done without first doing an operation to eliminate the infectious condition. After that part of the muscle may often be transferred over such a cavity after it is closed. In transferring a muscle over such a cavity it should be freely transplanted and held there without tension. The skin should be brought together over the muscle and the wound drained as there is apt to be some inflammatory disturbance.

Where sequestra are present it is always desirable to remove them as soon as they have separated and the involucrum is strong enough to act as a support. Sequestra may be superficial or in the mellullary cavity or both. Where there is a persistent sinus and a sequestrum is present, pus will continue to form until the sequestrum is removed, Cases discharging several years where sequestrum is present may close in a few weeks after removal of the sequestrum.

200. Plastic Operation for Open Wounds Following Osteomyelitis.—In cases of chronic osteomyelitis when the disease has practically subsided and the bone has remained gaping for a long time, it is sometimes very difficult to secure a closing of the wound. Not only the skin and soft tissues, but the bone edges are sclerosed. Various operations have been devised to promote healing. The following method is very useful. Although used for a long time the writer has not been able to find the physician responsible for the idea.

An incision is made to one side of the gaping wound down to the periosteum. This is lifted from the bone for the full length of the incision which should be a little longer than the gaping wound in the bone. A groove is cut in the healthy bone all the way for the full line of incision and down to the medullary cavity. When this has been done a sclerosed portion of the gaping bone should be excised completely down to the medulla. This leaves a long free piece of bone between this gaping wound and the groove. This bone is displaced toward the gap in the bone, completely closing it. The skin is brought together loosely over this and completely together in certain places. The gap will now be in the healthy bone which will gradually close after the patient recovers from the local reaction due to the operation. In all these cases there is usually a slight septic reaction following the closure of the infected surfaces.

201. Methods and Principles of Drainage in Acute Non-tubercular Suppurative Joint Disease. Ankle and Foot.—A small suppurative focus without virulence or active constitutional disturbance should be drained by a suitable incision, wiped out with gauze, a tube placed to its deepest part and the soft tissues gaped with gauze.

When there is a great deal of constitutional disturbance, drainage and

counter drainage should always be the rule; if the bone is involved this should be opened and counteropened as shown. The pus cavities in the soft tissues should be wiped out. No extensive bone operation should be done otherwise. The bone should be drained with tubes to the remote portions and the muscle, fat and skin gaped by gauze. These operations are done quickly and should not be prolonged, but efficient drainage and counter drainage should be established unhesitatingly. It is rarely necessary to do more at this time. If there is a marked sequestra formation this should be removed, but this had better not be done at the time of instituting drainage when the patient is nearly exhausted from an acute process. Any future operation made necessary should give good drainage and the removal of the sequestra if present and separated. See section 323.

Any extensive non-tubercular suppurating bone disease about the ankle should be drained by two lateral anterior or two posterior incisions and, if necessary, an anterior median. If the patient is very ill and the bone abscess not readily located the tissues are opened down to the bone. This should be done very rapidly and good drainage established.

Any chronic suppurating process should be well drained and counter drained, the pockets in the tissues well opened and wiped out and the diseased bone well drained in the same way.

PART IV—SHOULDER

CHAPTER I

OPERATIONS FOR DISLOCATIONS AND DEFORMITIES

202. Manipulation of the Shoulder Joint to Relieve Contractures.— It is important not to manipulate a joint where there is disease, or severe injury. Obtaining motion under an anæsthetic should be done only in cases with limited motion where there is no disease and where the limitation of motion is due entirely to extra articular adhesions or muscular contractures or very slight articular adhesions.

In manipulation of the shoulder to relieve contractures the normal motion of the joint should be remembered (see figures 306 to 313). The

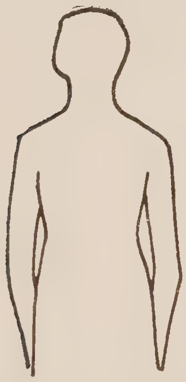

Fig. 306.—Neutral position as to rotation when the line between condyles of the humerus is parallel to a line between the anterior superior spines of the ilium.

Fig. 307.—Outward rotation of the shoulder.

Fig. 308.—Abduction of the shoulder.

Fig. 309.—Abduction of the shoulder with outward rotation.

stretching of the resisting tissues is made gradually, then relaxing, the force being applied gently and increased to a climax then gradually decreased until there is complete relaxation. The blood is thus allowed to enter and the tissues give way and stretch with less tearing and less trauma. A fair amount of normal action in all directions should be obtained at the shoulder before any operation on the muscles; such as a muscle transplantation, is done. A fair radius of shoulder motion is present when the fingers will reach the opposite scapula, the forearm passing in front of the face and the hand over the shoulder to the scapula; second, the arm passing behind the waist and upward to the scapula; third, the arm passing behind the head and neck and down to the scapula. Outward rotation of the shoulder is very important. It is easily lost and often difficult to obtain. If the elbow is held to the side and flexed at right angles, the shoulder should outwardly rotate (varying with the

individual) to at least sixty degrees from a position with the forearm pointing to the front, the inward rotation including some motion of the scapula might reach one hundred and twenty degrees. The humerus will extend forward and upward pointing fifteen degrees or more back from the perpendicular in standing, including some motion of the scapula.

The abduction (with a neutral position as to rotation) extends to about a right angle from the side; after that the scapula moves as the elbow is raised, unless the shoulder is outwardly rotated. When this outward rotation has taken place the arm may be abducted and raised further until the humerus is perpendicular in standing. The amount of adduction varies and may be estimated at about thirty degrees, varying in the individual; combined motions are also possible. Extension backward varies from thirty degrees to forty-five degrees. The operator

Fig. 310.—Inward rotation of the shoulder, the forearm lies across the body.

Fig. 311.—Abduction of the shoulder with neutral position as to rotation. No further abduction is possible without moving the scapula unless the shoulder is outwardly rotated.

Fig. 312. — Outward rotation of the shoulder and ninety degrees of abduction.

Fig. 313. — Extreme abduction of the shoulder possible with the humerus outwardly rotated.

should try each motion and gradually stretch until each motion is possible, holding the arm just below the flexed elbow and remembering the tremendous leverage possible.

An arm that has been out of commission for some time will have a very brittle bone. Manipulation in such cases should be done with care. The joint is gently stretched and relaxed, the operator applying force gently in a gradually increasing manner until considerable force is applied and finally relaxing entirely. In this manner a rhythmic extension and flexion is kept up. No rough or forcible extension without a gradually increasing or gradually decreasing force should be employed. By this method a minimum amount of trauma will be caused and a joint that at first seems almost impossible to move will often move considerably.

After obtaining the normal motion of the shoulder as completely as possible by manipulation, the arm is put up either straight up above the head and with the elbow slightly bent, or it is put up with the elbow a little above the shoulder. This position is maintained by a wire splint (see figures 314, 315), or a plaster of Paris bandage including the arm and thorax (see figures 316, 317, 318). After two to four weeks the arm

is lowered, depending on the swelling. If the arm is not put up straight above the head and outwardly rotated, the next best position is that of outward rotation and abduction, so that the humerus is forty-five degrees beyond right angle in abduction. It is held this way about two

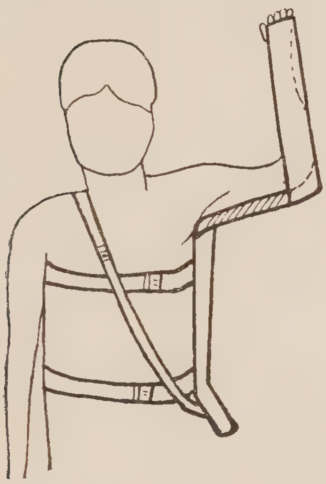

Fig. 314.—Wire arm shelf applied after shoulder operations. (It may be raised or lowered by bending the wire.)

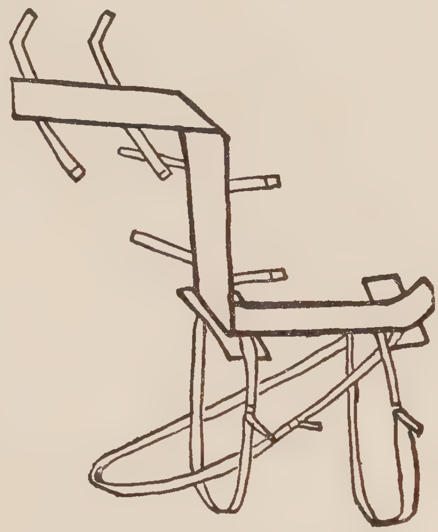

Fig. 315. — Wire arm shelf, showing straps for the thorax and for the arm.

Fig. 316. — Plaster applied after shoulder operations in a position of abduction and outward rotation.

to four weeks, a longer time if there is much swelling. Much swelling may be avoided by care in manipulation, force may be used but not roughness. An ice bag is of service applied immediately after the operation if the stretching has been difficult. In quiescent arthritic cases this should always be done. After the first two weeks if there is no swelling, the arm is lowered so that the humerus is horizontal, i. e., ninety degrees of abduction and forty-five degrees of outward rotation, the forearm with the elbow at right angles. This position is maintained by a wire splint in the form of a shelf (see figures 314 and 315). The wire is bent and lowered as the case improves. The arm is strapped to it allowing the use of the elbow, wrist and hand without removing the shelf. As the patient learns to exercise the muscles of the fingers, forearm and upper arm on the shelf, he is able later to lift the arm above the shelf. With improvement in strength the shelf is lowered to fifty degrees or sixty degrees of abduction and used this way for six to ten months depending on the strength of the arm. Much of the exercise each day should be done with the humerus held abducted sixty degrees and resting on such a shelf or table during the exercise. Later the exercise is repeated daily without the shelf.

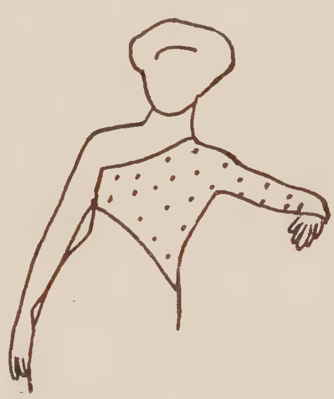

Fig. 317.—Plaster applied after shoulder operations in a position of ninety degrees abduction and neutral position as to rotation.

203. Operations to Correct Permanent Inward Rotation of the Upper Arm.—Inward rotation of the shoulder, when not due to a joint condition, is caused by a relaxed condition of the posterior outward rotators of the shoulder or a tense condition of the inward rotators. This may be actual, as in spastic cases, or comparative as in infantile paralysis. Sometimes with the primary cause there coexists adhesions and tissue shortening and sometimes depression of the acromium that must be taken into account. When there is a bony change that prevents correction of the deformity it will usually appear on palpation or in the x-ray or both.

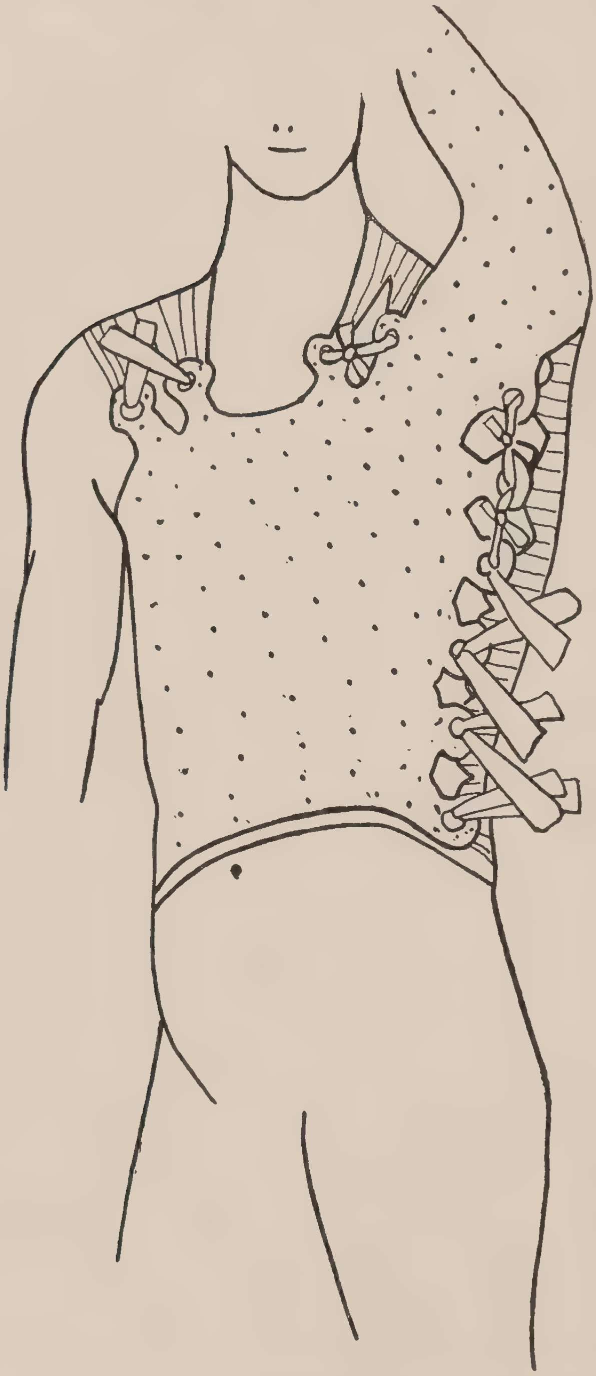

FIG. 318.—Plaster cuirass used after operation on the shoulder.

In slight cases, the outward rotation may be secured by reefing the posterior capsule which practically tightens up the infra-spinatus muscle. If this muscle is good the benefit will be more than temporary. Where the contracture is extreme, this will not be sufficient. The condition may also be relieved by lengthening the attachment of the pectoralis major, which is slit and overlapped as described elsewhere in these pages or by an osteotomy through the upper or lower third of the humerus, the lower fragment being outwardly rotated and allowed to heal in this position. In the obstetrical paralysis cases and certain spastic cases the best results are obtained by a myotomy of the pectoral and of the subscapularis suggested by Dr. Sever; this will allow the scapula to flatten into position. Often an osteotomy of the acromium is necessary beside.

204. Osteotomy of the Humerus to Correct Inward Rotation of the Shoulder.—The patient lies on his back, being placed close to the opposite edge of the operating table. The operator stands on the side of the arm to be operated on. The assistant stands to his right holding the forearm with flexion at the elbow. See figures 494–496.

An incision is made one inch long, just above the junction of the upper and middle third of the outer aspect of the upper arm, or in the upper part of the lower third. The skin is incised and retracted; the fat and the muscle fibers are separated by a blunt dissector, and retracted, ex-

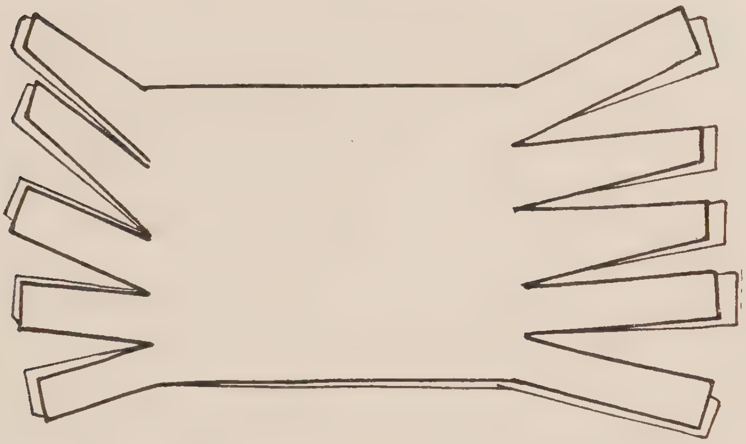

Fig. 319.—Double many tail swathe used behind the plaster cuirass.

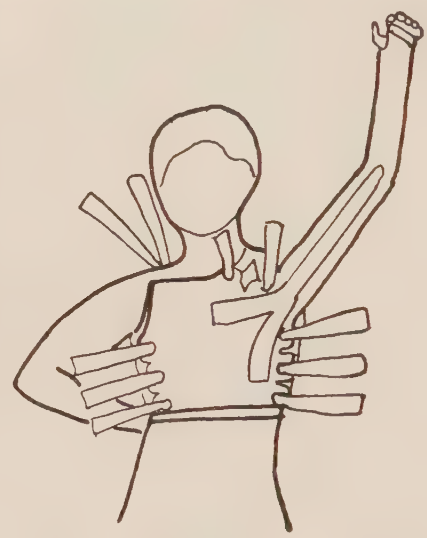

Fig. 320.—Manner of combining the plaster in front with the double many tail swathe behind and with the plaster arm above. Notice the plaster rope used to re-enforce the plaster and incorporated in its deep layers.

posing the bone. A very small incision is all that is necessary. An osteotome is applied to the bone (see figure 321). Before cutting the bone completely through, the surgeon assures himself that his assistant is steadying the elbow and forearm in order to allow practically no displacement and no trauma when the bone is cut through. After completing the cut in the bone, the wound is closed by one or two deep catgut sutures, number 00, including the skin. Five layers of gauze just covering the incision are applied as a dressing, over this rollers of sterile sheet wadding. The sterile sheet wadding rollers are applied gently and carefully in order to prevent any jarring or displacement of the bone. Coaptation splints are next applied as seen in figure 322. When the coaptation splints are snugly fastened, the arm is next gently rotated outward about thirty degrees. This thirty degrees is estimated from a position in which the forearm points to the front with the elbow at the side. A plaster of Paris bandage is applied holding the arm and forearm at right angles (see figure 323). Over this a snug swathe is applied holding the plaster at the shoulder and the elbow to the side (see figure 324). An internal angular splint over the coaptation splint,

Fig. 321.—Osteotome cutting the humerus.

a shoulder cap, an axillary pad, a swathe including the chest and affected arm may be substituted for the plaster, the outward rotation of the shoulder in this instance is maintained by

FIG. 322.—Sheet wadding applied without disturbing the arm. Coaptation splints applied before disturbing the cut bone.

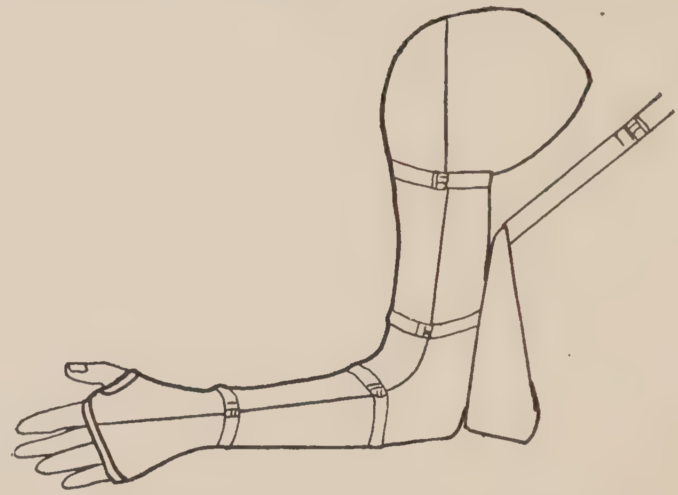

FIG. 323.—A plaster of Paris bandage and axillary pad applied over the coaptation splints.

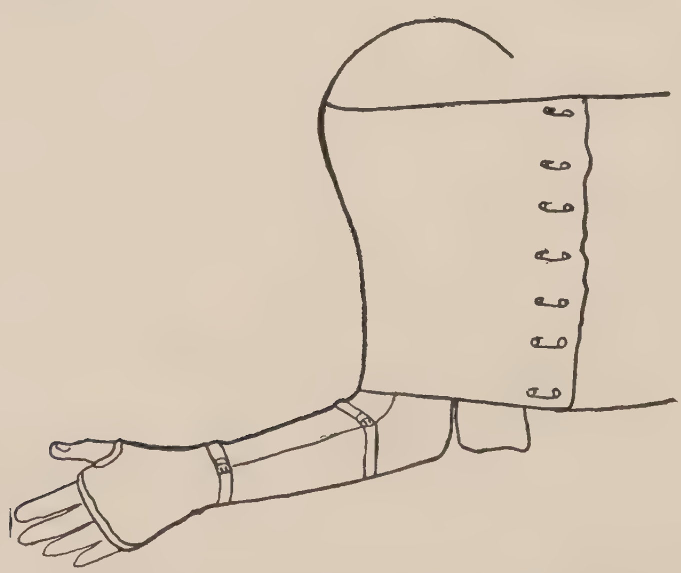

FIG. 324.—Swathe applied over the thorax and arm.

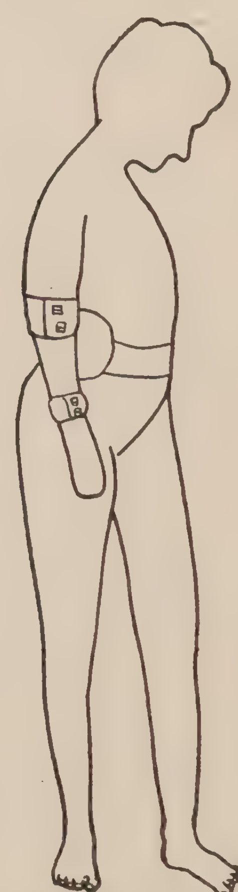

FIG. 325. — Splint and belt to prevent inward rotation of the shoulder, showing extension of the elbow. There is no limitation of flexion or extension of the elbow.

the use of adhesive straps looped around the forearm over the apparatus and over the outside of the swathe instead of being placed on the skin. Two adhesive straps are applied separately extending from the shoulder to the back and two straps applied separately from the shoulder to the front of the chest, and two from the elbow, one in front, and one behind the thorax.

Excellent results are obtained from this operation.

The pain suffered is practically nothing if the dressing is comfortably applied. There is little or no swelling.

After treatment

The patient should be kept in bed about ten days using a low bed rest constantly. The bed rest is raised for meals after the first week.

Fig. 326.—Splint and belt to prevent inward rotation of the shoulder, showing outward rotation of the shoulder.

Fig. 327.—Splint and belt to prevent inward rotation of the shoulder, with the shoulder rotated to a neutral position.

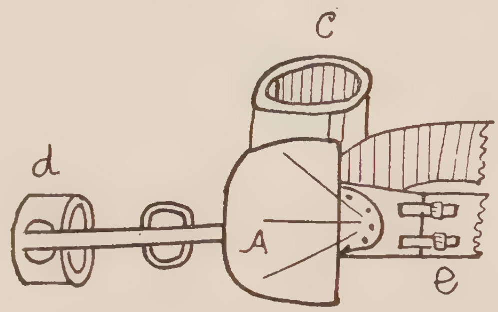

Fig. 328.—Splint and belt to prevent inward rotation of the shoulder. A, Plate to prevent inward rotation. B, Joint allowing flexion and extension of the elbow and outward rotation of the shoulder. C, Leather cuff for upper arm. D, Leather cuff for forearm. E, Belt.

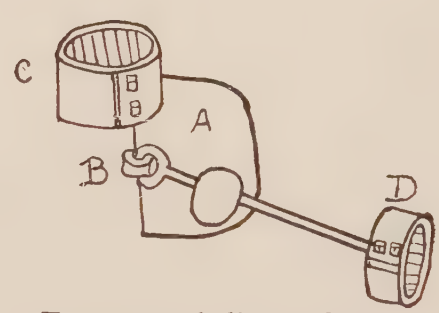

Fig. 329.—Splint and belt to prevent inward rotation of the shoulder, inner view.

The outward rotation is maintained for six or eight weeks allowing use of the hand in the third week.

The apparatus is removed a little each day after the sixth week. If the union is soft the apparatus should remain longer. After the eighth week the apparatus is worn part of each day and a belt apparatus maintains the outward rotation of the shoulder and allows the use of the arm and hand. It consists of a metal semicircle fastened to a belt preventing the inward rotation of the shoulder (see figures 325, 326, 327, 328 and 329). The humerus is fastened by a cuff to the belt preventing abduction of the arm. A wrist cuff is attached to a metal arm which strikes the aluminum semicircle and checks inward rotation. This apparatus is worn for the whole or part of the day over the clothes. In extreme cases, apparatus is necessary for a year, muscle stretching

and muscle training should be done twice daily as long as there is any tendency of the muscles to recontract.

205. Osteotomy for a Depressed Acromium.—When the acromium is depressed in certain paralytic conditions of the shoulder and in children with total or partial dislocation of the shoulder of long standing, the head of the humerus will be found slightly out of place and a limitation of motion caused from the deformity of the acromium. This turning over is demonstrable by the x-ray but may be easily felt.

An osteotome is used to incise the skin one and one-half inches from the tip of the acromium, a subcutaneous osteotomy of the acromium, is done, allowing the depression to be corrected and the humerus to slide into place. The incision may need one suture. The shoulder is held outwardly rotated ninety degrees and abducted ninety degrees for six weeks.

Fig. 330.—Deltoid fibers retracted showing fatty layers over the capsule.

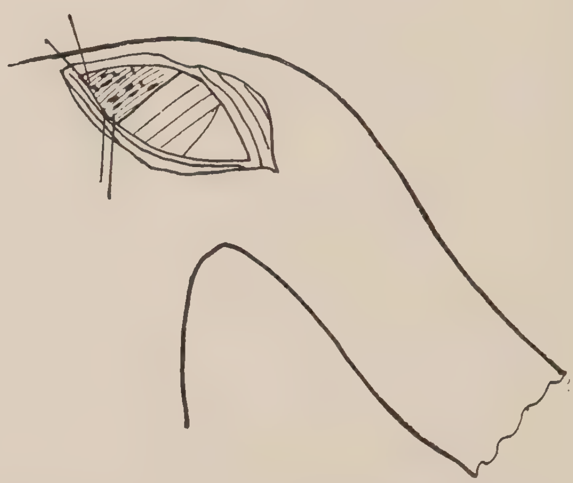

Fig. 331.—Sutures quilted into the capsule.

Fig. 332.—Capsule drawn tight after rotating the shoulder outward.

During the healing of the fracture, other treatment is sometimes necessary when the condition accompanies obstetrical or infantile paralysis.

206. Muscle Shortening. Operation for Shortening the Infra Spinatus to Correct Inward Rotation of the Shoulder.—The patient lies on his back, a hard pillow or sand bag lifts the right side of the thorax so that the scapula does not touch. After stretching the shoulder in outward rotation, sterile protection is used leaving the shoulder exposed above and posteriorly as well as laterally and anteriorly.

An incision three inches long is made through the skin and fat from the tip of the acromium backward and outward parallel to the outer fibers of the deltoid (figure 330); the deltoid fibers are next separated with a

blunt dissector exposing the thin fatty layer over the capsule; this is followed downward. A double set of mattrass sutures are quilted into the capsule and infra spinatus tendon which is continuous with it (figure 331). The shoulder is outwardly rotated as far as possible and each of the sutures tightened and tied (figure 332), maintaining the outward rotation. The arm is held in an outwardly rotated position by means of plaster of Paris or a wire splint (see figures 314 to 317). This operation is recommended by Professor Vulpius and others for persistent inward rotation of the shoulder (see Osteotomy). Section 204.

207. Muscle Lengthening to Correct Partial or Total Permanent Rotation of the Shoulder.—When the inward rotation of the shoulder is due to the short or contracted pectoral muscle the subscapularis will usually be found short also. This may be demonstrated by outwardly rotating the humerus. When this is performed the axillary border of the scapula will come forward. The latter may be cut across at its attachment or, as recommended by Dr. Sever, away from the capsule. The lengthening of the pectoralis muscle should be done in its outer portion. The fibers are cut across diagonally and sutured, or in a dentated manner as shown in figures 201, 202 and then sutured. The humerus should be placed in a position of ninety degrees of abduction and ninety degrees of outward rotation and held there for six weeks (see figure 316). After the third week the arm is put on a wire splint (see figures 314 and 315) and passive motion applied twice a day. After six weeks the arm is used on a shelf holding it adducted sixty degrees. The position of extreme outward rotation should be maintained for six or eight weeks, allowing the use of the wrist and hand after the first week. At the end of six weeks the apparatus is removed twice daily for twenty minutes. The time is extended every three days until it is removed six hours a day. After that the splint is used, maintaining extreme outward rotation for two hours daily for a year. Exercises and muscle training, especially in outward rotation, should be done for several years, depending on the tendency of the deformity to recur.

208. Operation for Inward Rotation of the Shoulder in Obstetrical Paralysis and other Conditions. Myotomy of the Subscapulares and of the Pectoralis Muscles. Dr. Sever's Operation.—In inward rotation of the shoulder due to obstetrical paralysis a certain number of cases cannot be benefited by conservative treatment. It is necessary to myotomize the pectoralis major and subscapularis muscles. When this is done the tendency to round shoulders and paralysis of all other muscles of the shoulder due to the contracture can often be prevented. The scapula fits back into place and the other muscles develop often to a surprising degree. After cutting the pectoralis major the surgeon may feel that he has done enough, but he will find that in outwardly rotating the humerus the scapula will come forward into the axilla. After cutting the subscapularis this will not take place.

This operation may be done also in cases of cerebral paralysis that have the deformity.

The arm is abducted and outwardly rotated. An incision is made from the acromium downward and outward between the deltoid and the pectoralis major muscles. When these muscles have been separated with a blunt dissector the fibers of the pectoral are lifted on a director and cut across, unless the operator decides to lengthen them as described elsewhere in these pages. The under fibers of the pectoralis tendon are tough and fibrous. These should be cut as well as the muscle fibers.

The shoulder should now easily rotate outward, but if the operator stops here he will find that a troublesome inclination forward of the scapula will persist when the child grows older. The outer border of the scapula and its angle will be found to come forward into the axilla as the shoulder is outwardly rotated. To avoid this Dr. Sever has suggested cutting the subscapularis in its tendon away from the capsule. The humerus is outwardly rotated, bringing the subscapularis tendon into view, it is attached high up in the inner border of the bicipital groove and is continuous with the fibers of the capsule. At this point a few muscular fibers extend here almost to the bicipital groove. The writer has incised the fibers here at the outer edge of the bicipital groove. This should not be done until the tendon has been traced to its attachment here. When it is cut the humerus may be outwardly rotated without bringing the scapula forward into the axilla.

The deep and superficial tissues are closed with interrupted catgut, the skin with continuous catgut sutures. The shoulder is held abducted ninety degrees; outwardly rotated ninety degrees with the elbow at right angles. A plaster is applied as shown in figure 316, including the thorax and arm. The plaster is bivalved so that the upper portion of the shoulder and arm plaster is removable, allowing the arm to slide out and be manipulated after the second week; in three or four weeks a wire splint is used (see figures 314, 316), allowing the arm to be used and manipulated so that there will be no danger of stiffness. At the end of three months the shoulder shelf is gradually discarded, being used two hours a day for one year after that.

This operation by relieving the strongly contracted muscles in obstetrical paralysis will allow the arm to grow in strength and usefulness, which is not possible otherwise. The muscles and use of the arm must be trained daily.

209. Operation for Inward Rotation of the Arm in Spastic Paralysis.—In certain spastic paralysis cases the inward rotation of the shoulder is very similar to that seen in obstetrical paralysis. In these cases it is often of advantage to cut the pectoral and the subscapularis muscles to allow free outward rotation of the shoulder without causing the outer border of the scapula to move forward into the axilla.

The operation is described in these pages for obstetrical paralysis. The after treatment is the same. See sections 207, 208.

210. Dislocation of the Clavicle.—A dislocation of the clavicle of long standing will require an incision along the end dislocated, often the sternal end. A sand bag is placed between the shoulder blades and the chest held well up, expanded over pillows, with the head held back.

This position is obtained before operation. The clavicle is exposed and the end loosened up subperiosteally, the shoulder hyperextended and the clavicles will readily slip in place.

If the loosening of the tissues does not complete reduction a small portion of bone is removed. The bone is freshened and drilled before reduction and held in place by heavy silk or by silver wire. A Sayre apparatus is applied as for fracture of the clavicle or a plaster of Paris jacket or posterior shell is used or a Sayre clavicle brace.

The treatment is the same as for fracture of the clavicle.

211. Partial Dislocation of the Shoulder due to Paralysis, often in Obstetrical Paralysis with or without Depression of the Acromium.—In dislocation of the shoulder due to paralysis of the muscles, the capsule must often be reefed, the shoulder outwardly rotated and abducted ninety degrees and held on a wire shelf while the partly paralyzed muscles are relieved of strain and weight-bearing and are exercised in this position for months. Good action of the shoulder is often prevented and the dislocation maintained by a depression of the acromium, this with the long capsule favor the dislocation. The depressed acromium is cut across at the root by an osteotome and the capsule reefed by quilted sutures. The arm is then held as above described for five weeks during the healing of the fracture and afterward as long as it is necessary to allow the muscles to become strong. See sections 205, 214.

212. Partial Dislocations of the Shoulder in Paralytic Conditions.—In conditions of partial dislocation of the shoulder in obstetrical paralysis and other paralytic conditions of the deltoid, the capsule is abnormally long allowing a displacement of the humerus.

The dislocation may be replaced and a few quilted sutures stitched into the capsule in such a way as to pucker the capsule and shorten it (see figure 333). See section 214.

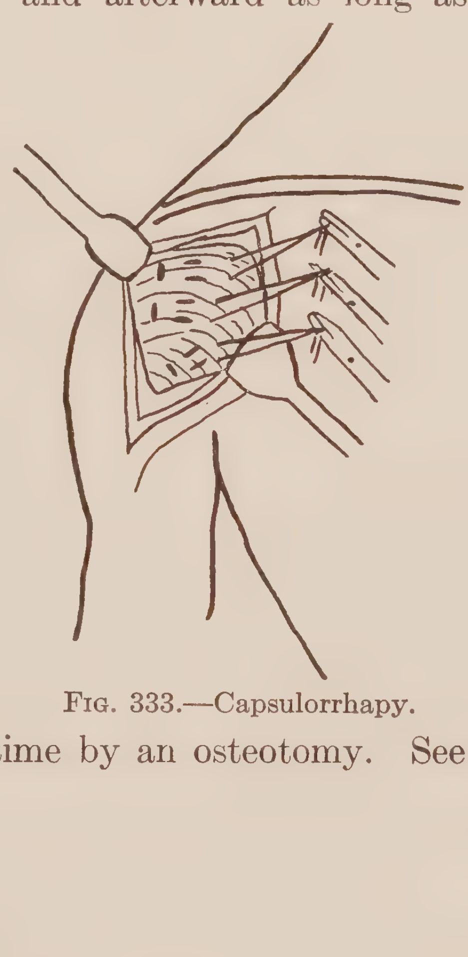

Fig. 333.—Capsulorrhapy.

This will suffice unless the dislocation is of long standing and the acromium has become depressed in which case this deformity should be remedied at the same time by an osteotomy. See section 205.

213. Open Operation in Cases of Irreducible Dislocation of the Shoulder.—A dislocation of the shoulder should be reduced by the usual manipulation; when it does not yield to this as in certain recent and in dislocations of long standing the open operation is indicated. An anterior incision or a Kocher incision may be used, preferably the anterior enlarged as described under arthrotomy.

In any so-called irreducible dislocation, the operator may make an attempt to reduce the dislocation by the usual methods before using the open operation; when there is evidence of adhesions or the dislocation is of long standing, after a well applied attempt an operation should be resorted to at once, in order to save time and not exhaust the patient. Extensive manipulations, especially in the old, are undesirable when an open operation is probable.

In some cases an excision is necessary either because reduction is impossible or the head is held too tightly by the contracted tissues. In dislocations of long standing where the joint cavity and head are injured and where reduction without tension may be effected an excision is not indicated.

Generally if the bone adjoining the head is well cleared subperiosteally an excision may be avoided. A subglenoid dislocation of five years' standing may be reduced by this method without excision.

The Burrell incision (figure 362) is a very useful one for these cases. It is necessary in these cases after opening the glenoid cavity which will be found much retracted, to replace the head and overlap the muscles in such a way as to complete the capsule where it is lacking. In some cases the very much lengthened muscles must be allowed to contract. For this purpose the elbows and forearm should be well padded and held by adhesive plaster straps to the opposite shoulder so that no weight will come on the sutured capsule and the muscles. The relief of pain following the operation is usually immediate.

214. Capsulorrhapy for Dislocation of the Shoulder in Paralytic Conditions.—The dislocation in paralytic conditions, when it is not traumatic, is usually due to a long relaxed capsule. The lack of muscle and tissue tone has allowed the capsule to be dragged out until it is too long.

An incision is made parallel to the inner border of the deltoid and one-half inch from it. The deltoid fibers are separated and the capsule is exposed, the arm is outwardly rotated ninety degrees and abducted ninety degrees, two or three sets of quilted sutures are placed in the capsule in such a way as to pucker it and as the sutures are drawn and tied this will remedy the lax condition. The arm is held on a wire shelf and the muscles exercised and strengthened on it for six to ten months depending on the amount of paralysis.

215. Operation for Recurrent Dislocation of the Shoulder.—In recurrent dislocation of the shoulder an incision is made between the pectoralis major and the deltoid extending inward one-half inch below

the clavicle. The joint is reached and the tear in the capsule located by a complete exposure of the joint. When the capsule is not easily closed, silk may be quilted across or the capsule released from the humerus subperiosteally and the tear is sutured with silk. The suture should not limit motion in outward rotation; for this reason the humerus is outwardly rotated while the sutures are being placed.

No motion in abduction of the shoulder should be allowed for at least four weeks. But slight motions are allowed in other directions especially in outward rotation after the tenth day.

216. Operation for Congenital High Position of the Scapula or Sprengel's Deformity.—An incision is made along the vertebral border of the scapula down to the bone; as the edge of the scapula is reached an osteotome is used to lift the muscles subperiosteally from its inner border upward and the muscles from the upper border. That part of the scapula above the spine which is often folded over should be chiselled away and removed. When the muscles are detached subperiosteally from the under side and upper end of the scapula by a subperiosteal dissection, using a long handled osteotome, the scapula will be released and may be depressed and if necessary held in position to the rib by a long chromic catgut suture number one.

A plaster of Paris bandage is used to hold the arm and thorax.

217. Application of Plaster of Paris Bandage to the Shoulder.—In applying the plaster of Paris bandage to the shoulder, the plaster should be low on the side of the chest of the affected shoulder; it should be very narrow and high on the chest under the opposite shoulder. It may reach over both shoulder or include only the affected or the well shoulder but it should include the humerus and forearm of the affected side (see figures 316, 317).

There should be a good deal of padding low down on the chest below the axilla of the affected side, also about the elbow and axilla. The elbow is usually held at right angles in order to maintain the necessary rotation. The plaster is halved so that the upper portion may be removed from the arm and forearm allowing the shoulder to be inspected or manipulated. The chest portion of the plaster is bivalved so that the front or back may be removed. This part of the plaster can be laced as shown in figures 436 to 440.

CHAPTER II

MUSCLE AND TENDON OPERATIONS. MUSCLE AND TENDON TRANSPLANTATION.

218. Operation for Paralysis of the Triceps, Transplantation of the Deltoid.—When the triceps is paralyzed and the deltoid remains good, a long vertical incision is made over the outer border of the deltoid down to the junction of the middle and lower third of the arm. The incision is made in the outer third of the posterior aspect of the upper arm.

Fig. 334.—Triceps dissected up.

The tissues are retracted exposing the deltoid. One-half or two-thirds of the upper fibers of the triceps are removed from their attachment and attached to the posterior half of the deltoid which is freed as low as possible. The upper end of the triceps is detached from the humerus. The fibers are scarified superficially on

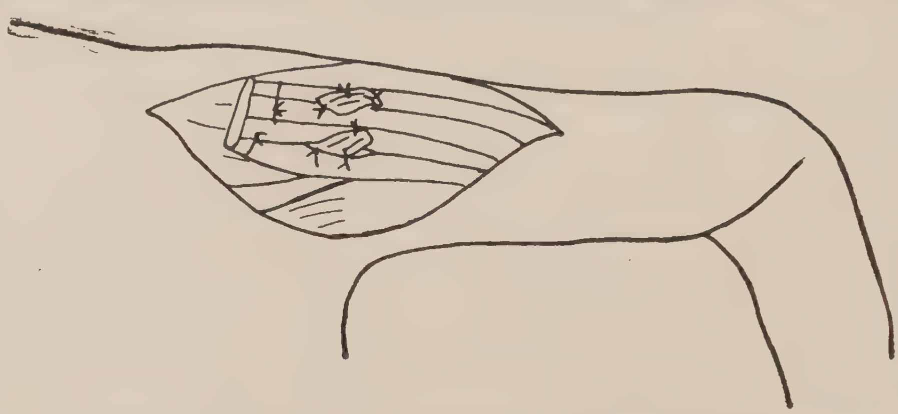

Fig. 335.—Split deltoid transplantation to the paralyzed triceps.

both sides. The posterior half of the deltoid muscle to be transplanted is divided into two halves (see figures 334 and 335). The fibers of the triceps are quilted with silk, quilted sutures are placed in each part of the slit deltoid, one set in each half that has been divided. The slit in the deltoid receives the triceps, one-half going anterior, the other posterior. The muscles are held together by these

quilted silk sutures and other mattrass sutures. The deltoid muscle is superficially scarified before being attached to the triceps. A plaster or wire splint is applied holding the elbow straight or in a few degrees of flexion and a large wedge pad in the axilla; a swathe is applied including the arm and thorax. A window is cut over the posterior part of the plaster which allows inspection of the incision. The after treatment

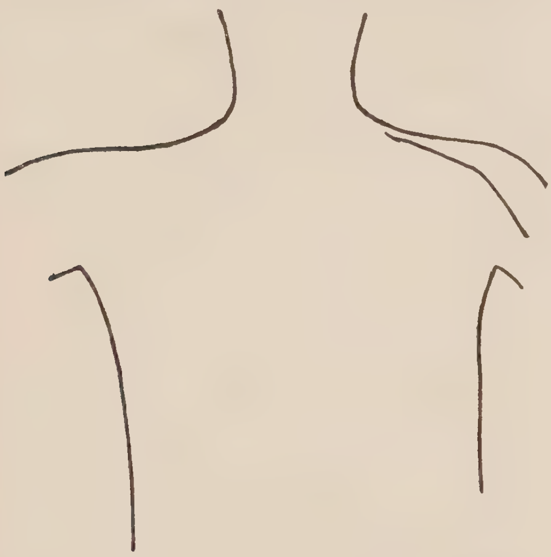

FIG. 336.—Incision over the trapezius and deltoid.

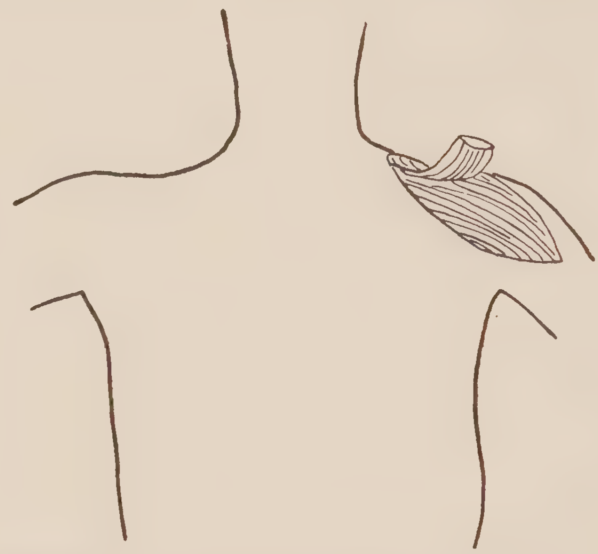

FIG. 337.—Part of the trapezius cut from its insertion and dissected up.

consists of absolute rest for two weeks in bed on an incline with a low bed rest.

The arm is kept extended six weeks and gradually flexed but not more than twenty degrees beyond a right angle position for over six months. Muscle training and exercises at home should be employed daily for at least a year.

219. Transplantation of the Trapezius to the Deltoid for Paralysis of the Deltoid.—In operation on the right shoulder, the patient lies on his back with a large sand bag or hard pillow under the right shoulder so that the shoulder and scapula are held off of the operating table. The operator stands above the shoulder.

FIG. 338.—The upper arm abducted and outwardly rotated to allow the insertion of the trapezius into the deltoid.

An incision is made along the edge of the trapezius to the acromion process. The skin and fat are dissected in one layer and retracted, exposing the trapezius muscle (see figures 336 to 341). Part of its clavicular and scapula insertion is dissected up and carried outward to the deltoid. Before insertion, both the deltoid and the trapezius muscle fibers are scarified superficially. The trapezius is quilted up one side and down the other with silk sutures and attached to the upper

end of the deltoid which is freed and the silk is quilted into it. Mattress sutures are also placed into the overlapping muscles. The shoulder should be flexed and raised (figure 316). The elbow is at the height of

Fig. 339.—The trapezius sutured to the deltoid and then the paralyzed deltoid sutured overlapping the trapezius.

Fig. 340.—Suture of the subcutaneous tissues.

the shoulder and held in this way during and after the transplantation. The deep tissues are brought together with interrupted chromic catgut sutures number 00, the skin with continuous chromic catgut sutures number 00. The abduction is ninety degrees, the outward rotation forty-five degrees.

The position is maintained as seen in figure 317, by a plaster of Paris bandage extending over the chest and arm. A wire splint replaces the plaster at the end of two weeks. The plaster is preferable at the time of the operation as it will be more comfortable and allow less motion.

The after treatment is the same as that prescribed for transplantation of the trapezius to half of the pectoralis major. See section 241.

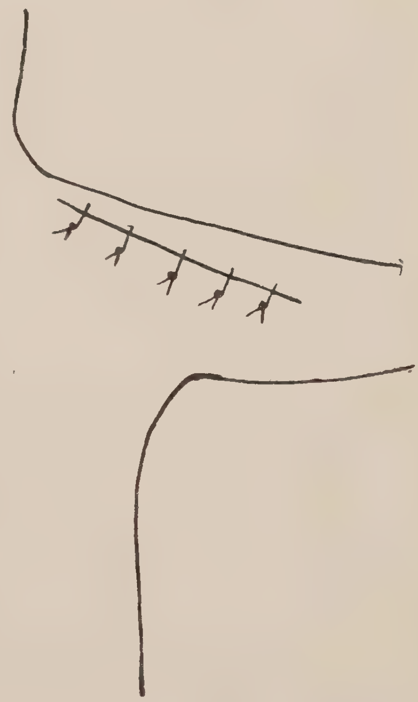

Fig. 341.—Incision sutured with continuous or interrupted sutures.

220. Operation for Paralysis of the Deltoid. Transplantation of the Trapezius to Part of the Pectoralis Major Insertion.—To transplant the trapezius to half of the insertion of the pectoralis major, the patient lies on his back, the operator stands on the side on which the operation is to be done.

An incision is made one inch above the lower edge of the pectoralis

major and parallel to it. The incision extends from the humerus four inches inward through the skin and subcutaneous fat. These are retracted. A broad portion of the lower edge of the muscle is detached from the rest of the muscle; the fibers are separated from within outward (see figures 342, 343). When the tendon is reached it is slit longitudinally. The muscle thus separated is reflected upward toward the shoulder; it is still attached to the humerus by one-half of the tendon.

Fig. 342.—Exposure of the pectoralis major.

Fig. 343.—One-half of the pectoralis major ready to be attached to a portion of the trapezius.

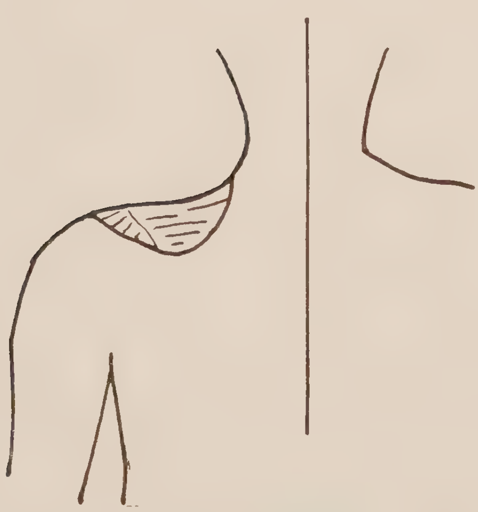

Fig. 344. — Posterior view. Exposure of the trapezius.

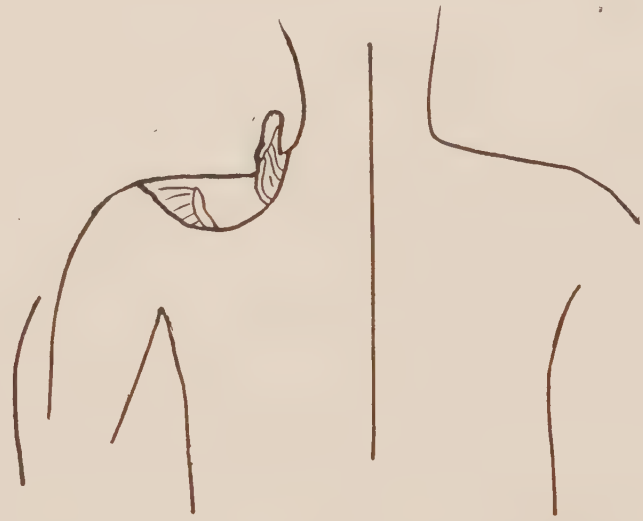

Fig. 345.—Posterior view. The trapezius cut away from its insertion, ready for silk sutures.

The separated muscle is raised, and a towel placed on the arm above and another below while two or three sets of quilted silk sutures are inserted into its fibers. The breakage of the silk should be tested before inserting it into the muscle.

A second incision is made along the anterior border of the trapezius (figures 344, 345). Part of the scapula and clavicular fibers are dissected up, the separated muscle is raised, a towel placed above and another below, while three sets of silk sutures are quilted into it. The superficial fibers of the pectoral and trapezius muscle are scarified.

A broad tunnel is made below the subcutaneous fat connecting the shoulder and pectoral incisions subcutaneously (figure 346). The pectoral and trapezius muscles are introduced and retracted allowing the muscles to be sutured together (figure 347). The muscles may be slit into three portions so that in overlapping, two tails of one muscle will go forward and one posterior while two tails of the other muscle will go posteriorly and one forward (figure 348). The muscles are sutured together and the quilted silk sutures already placed are extended from one muscle to the other and quilted in such a way that the silk coming from the pectoral is quilted into the trapezius. Additional mattress sutures are added if necessary. The muscle circulation must not be cut off by too many sutures. The deep tissues are brought together with interrupted chromic catgut sutures number 00, the subcutaneous fat with interrupted chromic catgut sutures number 00, the skin with continuous chromic catgut sutures. A plaster of Paris

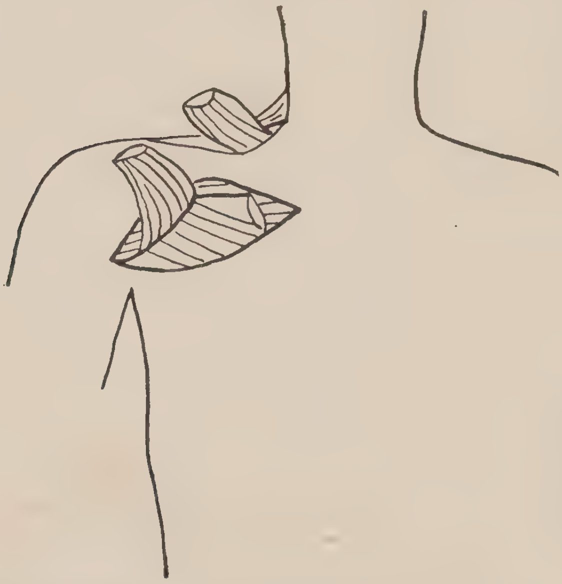

Fig. 346.—Intermediate silk and subcutaneous tissue raised allowing the trapezius and pectoralis to be approximated.

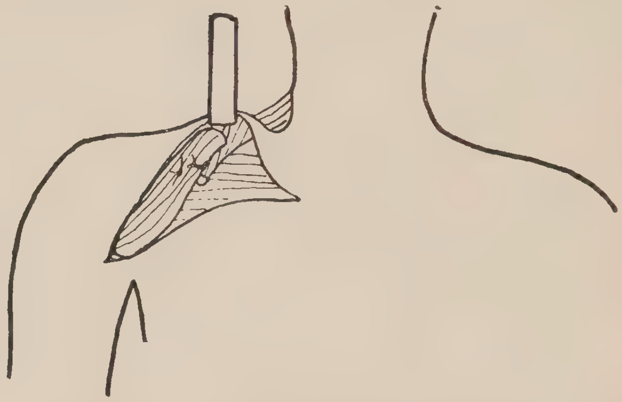

Fig. 347.—Another method of attaching the trapezius to the pectoralis; scarification and interrupted sutures.

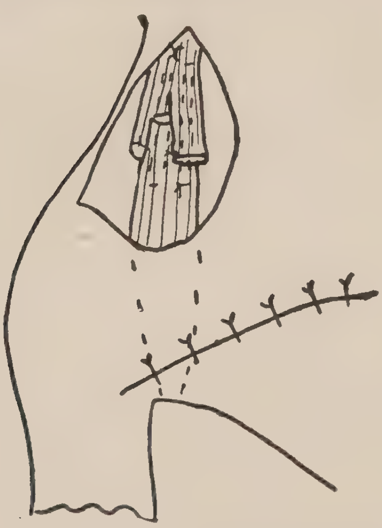

Fig. 348.—The split trapezius receives the pectoralis muscle and is fastened to it by quilted sutures.

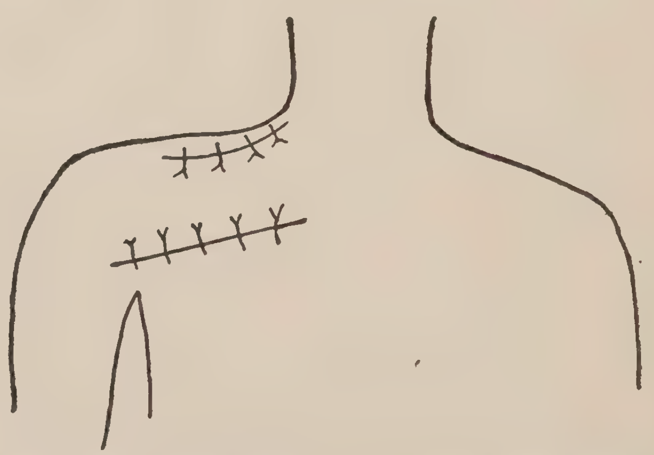

Fig. 349.—Both incisions are closed with interrupted or continuous sutures.

dressing is applied holding the arm raised above the head, as seen in figures 316 and 317. This position is maintained for about three weeks, after that the arm is gradually brought down and the plaster replaced by a wire splint (see figures 314 and 315). A wire shelf (figure 314), will replace the ordinary plaster at the end of two months. This should be used for nine months or a year, holding the arm in sixty degrees of abduction, the elbow not being allowed to drop below an abducted position of fifty degrees. The hand and forearm may be used on the shelf. Stretching, muscle training and exercises should be done daily until the muscles are sufficiently strong and serviceable.

221. Pectoralis Major Transplantation, for Paralysis of the Deltoid.—Dr. Legg recommends an incision one inch below the sternal end of the clavicle extending outward one inch below the clavicle and parallel

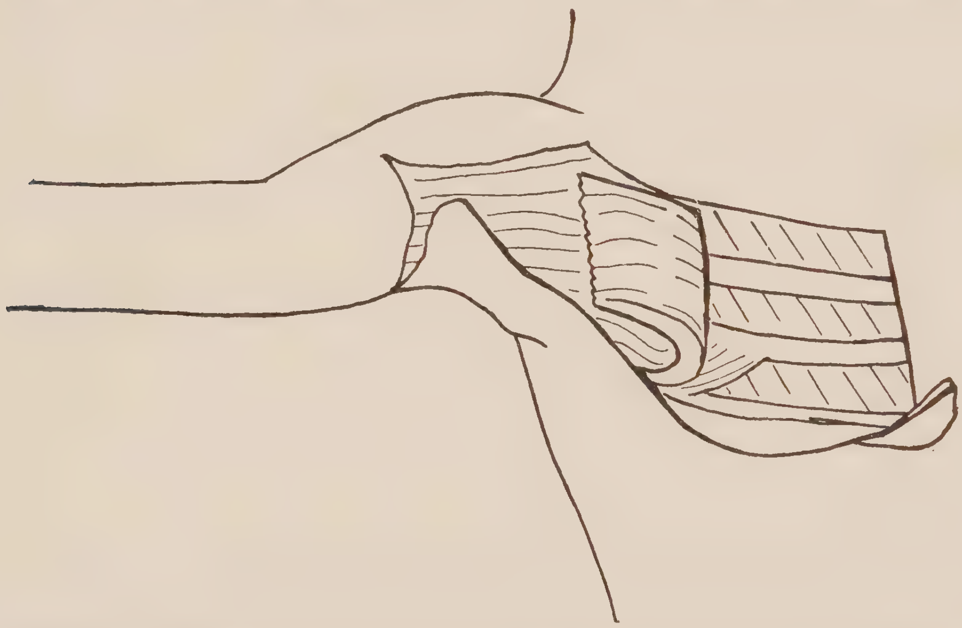

Fig. 350.—Exposure of the pectoralis major. The sternal end dissected up and turned back to cover the deltoid and the shoulder.

to it (see figure 350). The incision is continued along the anterior border of the deltoid almost to the deltoid tubercle.

The skin and superficial fat are reflected outward, the sternal origin of the pectoralis major is reflexed outward with the inner two thirds of the clavicular origin, avoiding the nerves which enter just below the outer third of the clavicle. The lower border of the pectoral is freed from its insertion (figure 351). The lower sternal origin is to be laid over the clavicle and extends back over the shoulder. It will fill well the space over the flattened paralyzed muscles.

An incision is now made along the spine of the scapula extending from the base of the spine outward to join the first incision. The skin and subcutaneous fat are reflected downward and upward exposing part of the trapezius. The dissected origin of the pectoralis major is now turned outward so that it lies over the scapula, the sternal portion of its origin is inserted with silk into the periosteum along the spine of the scapula. The clavicular portion and the upper sternal portion is

inserted into the substance of the trapezius muscle. The subcutaneous fat is brought together with interrupted chromic catgut number 00, the skin with continuous chromic catgut number 00. The arm is placed in a position of ninety degrees of abduction and held there by means of a plaster of Paris bandage or a wire splint made for the purpose. The

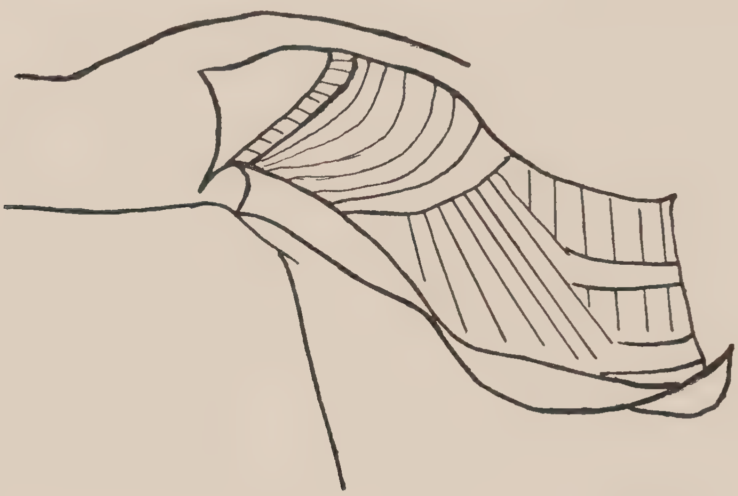

Fig. 351.—Pectoralis major reflected over the shoulder and attached to the spine of the scapula to become useful in raising the arm.

Fig. 352.—Exposure of the triceps.

after treatment is the same as that described under transplantation of the trapezius and one-half of the pectoralis major insertion.

222. Operation for Paralysis of the Biceps, Transplantation of the Triceps.—The patient lies on his left side for transplantation on the right arm with large pillows or sand bags to steady him. The operator stands behind the arm to be operated on.

An incision is made in the outer third of the posterior aspect of the upper arm, extending from the upper and middle thirds down to just below the external condyle (figure 352). The incision is carried down to the muscle, the skin and fat are retracted exposing the outer edge of the triceps and its tendon. The outer third of the tendon is detached below the elbow and dissected upward to one and one-half inches above the joint (see figures 353 and 354). At this point the outer half of the muscle is divided and its muscle fibers separated to almost the junction of the upper and middle thirds of the arm. A second incision is made anteriorly in the middle third of the upper arm down to the biceps. The incision is then carried downward to the bicipital fascia on the front of the forearm. A subcutaneous tunnel is made under the fat connecting the upper ends of these two incisions, a tendon carrier or clamp is passed from the anterior incision backward. The triceps tendon is grasped and drawn forward out of the anterior incision (figure 354). Number eighteen braided silk is quilted up one side of the tendon and down the other (figure 355). At this point one of four methods may be adopted, either the biceps is scarified superficially, the triceps also, the

two placed in apposition and sutured, the quilted end of the triceps is inserted and fastened to the bicipital fascia below the elbow; or second, the biceps may be lifted on a blunt dissector, its fibers separated longitudinally, the triceps passed through the slit and its end carried down to the bicipital fascia (figure 355) where it is sutured, other mattress sutures being placed to hold the muscles in apposition; or third, the triceps may be passed through a slit in the biceps in the middle of the upper arm and again through a second slit lower down and sutured in the same way;

Fig. 353.—The triceps split and one half to be transplanted forward.

Fig. 354.—One half of the triceps drawn forward through the tunnel.

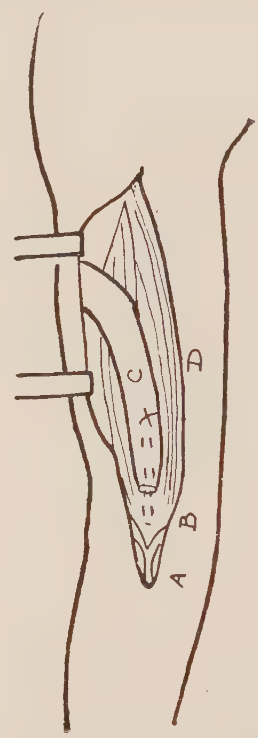

Fig. 355.—One half of the triceps C drawn forward and sutured to the biceps D, quilted silk extension to the bicipital fascia B.

or fourth, the biceps may be cut away bodily at the middle of the upper arm and attached to the triceps by interrupted chromic catgut mattress sutures wherever necessary. The end of the triceps in all cases should be attached below the bicipital fascia, by means of silk as described above. The arm is put up in a plaster of Paris bandage or a posterior wire splint with the elbow flexed to forty-five degrees more than right angle.

Right angle flexion should be maintained at least nine months, allowing the use of the forearm and hand and allowing motion in flexion at the elbow but not extension beyond the right angle position. Muscle training and exercises should be done daily for a year or more, depending on the case.

CHAPTER III

OPERATIONS IN PARTIAL AND TOTAL PARALYSIS

223. Flail Conditions of the Shoulder and Partial or Total Dislocations of the Shoulder Due to Paralysis.—In paralysis of the shoulder the deltoid may be partially or completely paralyzed. See also Chapter II.

When a flail condition has existed for a long time, especially when it has existed from infancy, there is often a dislocation and a rounding down of the acromion process over the shoulder. When a transplantation or capsulorrhaphy is advisable here, it is sometimes necessary to do an osteotomy of the acromion to allow the shoulder to be relaxed. The curved acromion will often interfere with the normal motion of the joint.

224. Operation for Depression of the Acromion over the Head of the Humerus and Capsulorrhaphy.—For operation on the right shoulder, the right side of the patient is elevated by sand bags or hard cushions under the right thorax from the angle of the scapula downward. The shoulder and upper three-fourths of the scapula are held well off of the table. The cushions should be placed to insure a firm position of the patient so that neither he nor they will slide during the operation and manipulation of the arm. The operator stands above the shoulder with his left side toward the head of the patient and traces the curving acromion with his left hand.

An incision is made down to the bone three-fourths of an inch long and about one and one-half inches from the tip of the acromion. An osteotome is used to cut the bone. The acromion process is very readily reached and cut, through an extremely small incision. A second incision is made over the anterior aspect of the humerus about one-half inch from the anterior border of the deltoid and parallel to its fibers. See figure 356. The incision is carried through the deltoid fibers separating them with a blunt instrument. The joint capsule is readily reached and reefed by inserting three or four heavy silk quilted sutures (see figure 333). These are tightened and tied holding the head of the humerus close to the glenoid. They should not interfere with motion. The deep tissues are brought together with interrupted chromic catgut sutures number 00 and the subcutaneous tissues with interrupted chromic catgut sutures number 00, the skin with interrupted horse hair, or subcutaneous or continuous chromic catgut sutures number 00. The shoulder should be held abducted to right angle and outwardly rotated about sixty degrees (see figure 316). A plaster dressing is applied over the opposite shoulder and the chest and including the arm and hand, allow-

ing free play of the fingers and thumb. A wire splint is sometimes used instead of the plaster (see figures 314 and 315). The arm is kept in this position six or eight weeks. After that the treatment is the same as that described under transplantation of the trapezius.

225. Arthrodesis of the Shoulder in Paralytic Conditions.—In paralytic cases, the object of this operation is to take advantage of the good muscles attached to the scapula and use them to control and raise the shoulder. This is accomplished by placing the arm in an abducted position and fixing it to the scapula.

For operation on the right shoulder, the right side of the patient is elevated by sand bags or hard cushions under the right thorax from the angle of the scapula downward. The shoulder and upper three-fourths of the scapula are held well off of the table. The cushions should be

Fig. 356.—Retracted deltoid exposing the joint capsule.

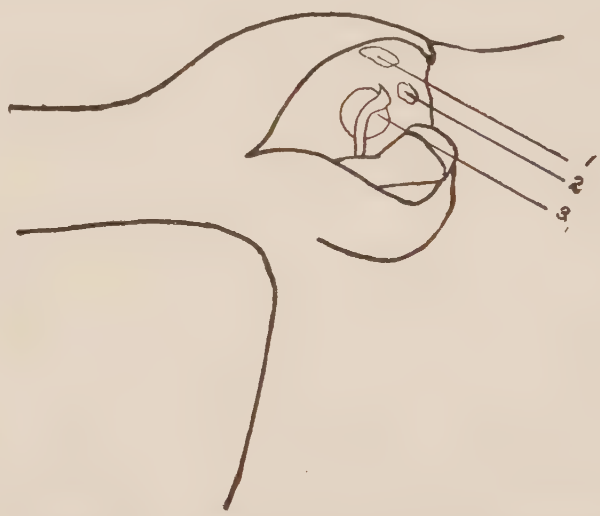

Fig. 357.—Tendon of the biceps displaced inward, head of the humerus dislocated exposing the glenoid. 1, Acromion. 2, Coracoid. 3, Tendon of biceps, behind it the glenoid.

placed to insure a firm position of the patient so that neither he nor they will slide during the operation and manipulation of the arm.

An anterior incision is made from the space halfway between the acromion and coracoid process down the arm parallel to the bicipital groove almost as far down as the insertion of the deltoid. The incision is carried through the deltoid, its fibers being separated with a blunt instrument a short distance from its inner border, the muscle fibers are retracted, the bicipital groove is located, the joint capsule opened here (figure 356). The tendon of the biceps is exposed and raised from its groove and displaced inwardly over the head of the humerus. This is facilitated by rotation of the arm. The capsule is elevated and dissected free from the humerus close to the bone (this may be done subperiosteally with an osteotome). The arm is manipulated and rotated to aid the dissection, allowing the capsule to be dissected from the humerus by rotating inward and outward. The head is displaced well forward allowing free access to the glenoid cavity (see figure 357).

Three or four quilted silk sutures are placed separately into the freed capsule so that both ends from each strand quilted in are firmly attached to the capsule and used to hold it retracted and later aid in finding the edges for suture. The glenoid surface is denuded to the bone. The surface of the head of the humerus coming in contact with the joint should then be removed so that the head of the humerus and denuded glenoid will be in smooth flat contact assuring a complete ankylosis between the scapula and the head of the humerus with the arm placed in a position of about seventy degrees of abduction. These bones may be drilled and fastened together with heavy silk sutures. Other silk sutures may be placed through the acromion and the tuberosity of the humerus. The arm should be abducted about twenty degrees more than the final position desired. When the silk is tied the humerus should be held firmly to the bone in the desired abducted position. The capsule sutures already placed are brought together and tied, holding the bone firmly in place. The deep tissues are brought together with interrupted chromic catgut sutures number 00, the subcutaneous fat with interrupted chromic catgut sutures number 00, the skin with continuous chromic catgut sutures number 00.

The shoulder is held firmly in this position by a well fitting plaster of Paris bandage padded throughout. Extra padding is placed under the elbow over the shoulder and over the thorax in the axillary line. A small window is cut for inspection of the incision without disturbing the plaster. The arm is held in plaster six weeks. The patient is kept in bed for two weeks. Motions of the hand and wrist are encouraged after the second week. After the sixth week, a wire shelf (see figures 314 and 315) is used bent down to maintain the desired abduction, about seventy degrees. This allows the use of the arm, forearm and hand and abduction of the shoulder but prevents adduction. Exercises and muscle training should be used in connection with the splint for at least a year. After that the splint is used two hours a day, depending on the strength of the scapula muscles. The object of the operation is to take advantage of the scapula to raise the arm when the shoulder muscles are paralyzed.

226. Bartow Silk Ligaments at the Shoulder in Paralytic Conditions.—At the shoulder when there is a complete paralysis of the deltoid and it is inadvisable to do a transplantation, the Bartow silk ligaments may be used to hold the shoulder to the scapula. They will also hold the head of the humerus close to the acromion and allow better use of the muscles when there is a partial paralysis.

OPERATION

An assistant holds the humerus close to the acromion in a neutral position as to rotation, the elbow being flexed at right angles, the forearm points directly forward. The Bartow drill described above is inserted through the acromion from above downward and outward. The

drill should protrude through the handle a very little. As it cuts the bone the handle is placed one-half to three-fourths inches further back, keeping the handle as low as possible on the drill. The drill is passed through the head of the humerus and out at the side. As it protrudes through the skin a heavy number eighteen silk is threaded through the eye in the drill and drawn through the skin on the top of the shoulder. The drill is next passed downward subcutaneously through the joint capsule if possible and protrudes through the opening in the skin below. The silk is removed from the drill, the drill withdrawn, leaving both ends of silk protruding through the lower hole in the skin. The humerus is placed in the desired position close to the acromion, the silk is tied tightly three times, the ends cut and allowed to recede through the hole in the skin and fat. The after treatment is the same as that described in these pages for arthrodesis of the shoulder. See section 225.

CHAPTER IV

INCISION PUNCTURE AND ARTHROTOMY

227. Arthrotomy.—A knowledge of the important routes of approach to the joints will facilitate any joint exploration, the removal of foreign bodies, the repair of traumatic conditions, the adjustment of difficult fractures, the reduction of old and difficult dislocations, mobilization of joints where motion is partially or totally lost, and stiffening the joint as in certain paralytic conditions, treatment and drainage of suppurative conditions; a knowledge of the important routes of approach to the joint is very important. For each case, the operator will select the incision best suited for the individual condition. Each joint will be considered separately in its chapter.

In all operations on the joints, the incision should be made down to the synovial membrane and made large enough before opening the synovial cavity. All bleeding should be stopped and the synovial membrane carefully opened. The joint structures should be tampered with as little as possible, the synovial membrane brought together carefully and the layers over it closed in order not to disturb the function of the periarticular tissues. Unnecessary separation of the tissue layers is to be avoided. Tendons should be left in their sheath. Any ligaments that must be cut should be loosened subperiosteally, in order that they may be readily replaced. Early motion should be the rule, gentle at first, and gradually increased.

The shoulder joint is readily opened or punctured for diagnostic purposes but joint operations should never be hastily considered and should be avoided by anyone not familiar with the best surgical technique.

Arthrotomy of the shoulder is necessary sometimes for bursitis, sometimes for the rupture of the supra-spinatus, sometimes on account of disease, sometimes for exploration, in cases of obscure internal derangement of the joint, or for removal of a foreign body, dislocation, fracture, for acute infections or suppuration.

Incision in the overlying tissues should be made to one side of the line of incision in the capsule. All bleeding should be stopped before opening the synovial cavity. The latter should be opened carefully and the cavity itself interfered with as little as possible, avoiding rough and sharp instruments.

For reefing the capsule, the anterior incision is often the best, but the posterior may be used. For drainage, the operator may choose the anterior route or the posterior, or both. In any extensive suppurative condition, the joints should be thoroughly drained. At times an anterior

incision with a puncture posteriorly will give sufficient drainage. This is especially so in the case of suppurative bone conditions.

228. Anterior Incision. (See Fig. 358.)—An incision is made from one-half inch below the acromion downward parallel to the deltoid muscle and slightly external to its innermost border. The incision is made three or four inches long. A layer of delicate fat is reached before opening the joint cavity. The sub-acromion bursa will be found under the deltoid andacromion (see figure 358).

When more room is necessary

When it is necessary to have more room than is afforded by this incision, it is extended downward, but if very much room is needed it is better to make a second incision joining the first one-half inch below the acromion, extending inward one inch below and parallel to the clavicle, separating a few of the deltoid fibers (see figure 359). This extra incision is not often necessary but it is very useful in difficult fractures and dislocations. The synovial cavity is opened in the line of the bicipital groove which is easily felt with the finger. A director is placed in the groove and the capsule opened on it.

If it is necessary to have a full view of the head of the humerus, the tendon of the biceps is lifted from its groove with a blunt dissector and displaced inward. The shoulder is rotated inward, then outward slowly giving access to the restricting portions of the capsule which are removed subperiosteally to allow the head to be turned out through the incision by adducting the arm. This will allow a very good view of the head and glenoid.

Fig. 358.—Anterior incision starting one inch below the acromion and extending downward parallel to the deltoid fibres.

Fig. 359.—Anterior incision with extension one half an inch below the acromion extending inward parallel to the clavicle.

The anterior route is a simple and very useful route of approach for operations on the capsule, for excision, arthrodesis, and certain fractures.

When the purpose of operation is accomplished, the head is replaced, the biceps tendon placed in its groove and the overlying tissues sutured layer by layer with interrupted chromic catgut sutures number 00.

229. Posterior Incision.—An incision is made starting one-half inch posterior to the tip of the acromion downward parallel to and one-half inch from the posterior border of the deltoid (figure 361). The

incision is carried through the skin and fat for about three inches. The deltoid fibers are separated with a blunt instrument, the fat overlying the synovial membrane is carefully opened and finally the synovial membrane is lifted with forceps and incised.

230. Kocher Incision.—This incision is carried from the acromio-clavicular joint along the upper border of the acromion and the spine of the scapula to its root. From this point, the middle of the spine, it is curved downward and forward to the posterior fold of the axilla (figure 360). The acromio-clavicular joint is cut across or preferably the fibers of the acromion legament are detached subperiosteally from the acromion. The finger or a blunt dissector separates the deltoid from the underlying tissues. The muscles are separated subperiosteally from the upper and lower border of the spine of the scapula. The acromion is

Fig. 360.—Kocher incision from the acromio-clavicular joint backward to the root of the spine of the scapula and then downward and outward to the posterior axillary line.

Fig. 361.—Codman incision between the acromio-clavicular joint extending forward, separating the deltoid anteriorly parallel to its fibers and backward parallel to the posterior margin of the deltoid. The posterior portion corresponds to the posterior incision.

chiselled through and is retracted forward with the deltoid. The operator should take care not to injure the supra-scapula nerve which passes under the muscles from above to below the spine into the infra-spinatus fossa. A hole is drilled through the acromion and another through the spine before separating the latter with a chisel. Sutures are placed through these holes before separating the acromion with the chisel. This enables them to be replaced easily afterward, the head of the humerus and glenoid fossa are fully exposed, after lifting the bicipital tendon from the groove and displacing it inward.

231. Codman Incision.—The saber cut Codman incision is made over the acromio-clavicular joint extending forward and backward along the anterior and posterior border of the deltoid (figure 361). The incision is continued along the spine of the scapula to its root. The acromion is separated from the spine by means of an osteotome or by a gigli saw. The acromion is first detached from the clavicle anteriorly. It is displaced forward with its deltoid attachment exposing the glenoid and the humerus.

This incision may be used for fractures or dislocations or for exploration of the shoulder joint.

After operation the shoulder should be held by a long axillary pad or by means of a wire or plaster splint holding the arm extended straight above the head or abducted ninety degrees and outwardly rotated forty-five degrees to ninety degrees, depending on the case. Motion in outward rotation is very easily lost and very important for future function.

FIG. 362.—Burrell incision. The arm is abducted. The incision separates the pectoral from the deltoid extending inward below the clavicle one or two inches.

During convalescence motion in the joint is encouraged early without changing the position of abduction and outward rotation on the splint. When small arcs of motion are successfully obtained without much discomfort more motion is allowed. Exercises are done often during the day but a very little at a time at first. After ten days there should be a marked increase in the ease and in the arc of motion.

232. Fractures of the Shoulder.—A fracture through the surgical or anatomical neck or head or tuberosity with or without dislocation will very frequently require treatment by the open method. The bone is easily reached by the usual shoulder incisions. As these fractures are difficult to treat no attempt at reduction should be made until a careful diagnosis is obtained from an x-ray. There is no necessity for haste. If necessary, the operation may be delayed several days for the sake of good x-rays. The surgeon having assured himself of the exact condition of the bone, the fracture is adjusted and plated or wired or bone grafted as the case requires. See sections 261, 262. The arm should be held to the side, the forearm pointing forward, with a large or small triangular pad in the axilla, coaptation splints, a shoulder cap, an internal angular elbow splint, a body swathe holding the arm to the side, and the patient kept in bed on a bed rest, the elbow unsupported in order to allow its weight to act on the lower fragment in preventing over-riding.

When the fracture has healed, if the original trauma has been great, it may be necessary to abduct and outwardly rotate the shoulder and hold it on a wire splint and exercise it in this position and later on a wire shelf abducted ninety degrees. The shelf is gradually lowered as the deltoid and other shoulder muscles acquire strength. Motion is necessary after the third or fourth week. Long immobilization must be avoided.

233. Fractures About the Shoulder.—When it is necessary to operate on shoulder fractures they are usually reached through a simple anterior incision or an enlarged anterior incision. For posterior frac-

tures or fracture of the tuberosity the Kocher incision may be used. For small fractures of the tuberosity a simple posterior incision is often sufficient.

Fractures of the surgical neck are reached by an anterior incision, the head may be drilled and held by the drill during the adjustment of the fracture.

In difficult cases both an anterior and a posterior incision may be necessary.

A most complete exposure is obtained by a Kocher incision or a Codman incision.

234. Arthrotomy for Fractures about the Shoulder Joint.—The necessity of immediate operation in fractures about the joints depends, as in other fractures, on the acuteness of the local and general reaction. When these do not contra indicate immediate operation, certain fractures about the joints may require treatment by the open method. Among these are fractures of the patella, fractures of the olecranon and certain fractures of the surgical neck of the humerus, fractures and dislocations combined and certain fractures of the neck of the femur, all compound fractures, even when the protrusion of the bone has been extremely slight, all fractures that cannot be reduced by manipulation or in which the correction cannot be maintained or where apposition is impossible, many fractures combined with dislocation, articular fractures with pieces locking or limiting the joint action.

Where there is a great deal of trauma and in multiple fractures and in cases where there is a great deal of shock all that can be done is to immobilize the parts until a favorable time for operation. In selecting a suitable time for operation when it is found necessary to operate on a fracture if there is no immediate contra indication, the sooner it is done the better. When there is tremendous swelling one should always wait. All cases should be operated on that show no union after three months of good treatment.

Methods of treating the individual fracture cannot be considered in a limited space like this. The writer has described the routes of approach to the different joints and the technique of these. This will enable the surgeon from his knowledge of fractures to select the route best adapted for the individual treatment required and when necessary two or more incisions may be used. A knowledge of the technique will enable the surgeon to work rapidly in reaching the fracture on which he expects to spend time. See section 232.

235. A Traction Apparatus for Fractures of the Shoulder and the Shaft of the Humerus.—When traction is of advantage, the same apparatus may be used for fractures at the shoulder and for fractures of the shaft of the humerus that is described under fracture at the elbow. Section 262.

236. A Method of Treating Overlapping Fractures.—Where the bones overlap, an excellent method of treatment is one suggested to the

writer many years ago by Dr. Edward Martin of Philadelphia. In the operation when the surgeon has reached the fracture the ends are freed. A tough tape or webbing is used ten or twelve feet long, sterilized. The two ends of the tape are tied together, a loop of the tape is placed over the distal end of the bone. The other end of the tape is thrown over the foot of the operating table, a thirty-five pound weight is attached to this by an assistant. In about five minutes the bones will be found to be separated at least one inch. The weight is then held up by a non-sterile assistant, the tape taken off of the end of the bone and clamped to the sheet on the operating table, so that it will not slip away while the surgeon works on the fracture. When the muscles are in fairly good tone or the overlapping of bone has been great, it will be found that the bones will overlap again in four or five minutes. A reapplication of the tape will separate the bones again for the same length of time. The end of the lower bone should not be cut or freshened until all other procedures are done which require separation of the bone. When these have all been done the end of the bone over which the tape has been placed is freshened. After this the tape should not be placed on the end of the bone, unless it is very necessary but the two ends allowed to come together and held by a clamp until the operation is complete.

Very bad overlapping fractures have been treated in this way in fresh cases without the necessity of shortening the bone. In old fractures no more bone need be removed than is required by the conical condition of the ends. See section 232.

237. Fractures of Long Standing Still Ununited or United with Deformity, Preventing Function.—In fractures of long standing where there is a mild infection, conservative treatment should be tried first. When this has been tried free drainage should be established and at the same time the ends of the bone freshened up slightly. Unless the infection is marked, in many of these cases when the suppuration disappears, union has also taken place. In any case where there has been infection, no plastic operation should be used until the infection has been entirely absent for at least nine months, a year is safer. Where the infection is very mild and of long standing, during the process of treatment the patient may be allowed to walk on the other leg if the local reaction is not too great. Sometimes he may walk a little on the affected leg. It is of advantage in certain cases to use a Thomas splint to take some of the weight off of the affected leg, the patient being allowed to bear weight on the ball of the foot, the splint taking all the weight off of the heel. Where the x-ray shows conical ends of the bone it is practically useless to expect union without surgical interference.

238. Tapping the Shoulder Joint.—The most scrupulous aseptic precautions are necessary both as to the preparation and the protection of the field of the operation.

It is rarely necessary to tap the shoulder joint. When there is much swelling, the synovial cavity is more readily reached. It is tapped ex-

ternally just anterior to the acromion halfway between it and the most anterior portion of the deltoid, obliquely down and back. The subdeltoid and subacromial bursa must not be forgotten. The tapping may be done with ethyl chlorid or novocaine adreneline solution, 1%.

When there is much effusion it is not difficult to reach the joint. The skin is drawn to the side so that the hole in the skin and muscle will be out of line when the needle is removed. If fluid is to be drawn, and other solutions are to replace it, the amounts should be carefully measured. Two good graduated metal syringes are very useful. All of their parts should be tested beforehand. The trocar is made to enter the joint and then is connected with the syringe. As little air as possible should enter the joint. The trocar should be of large diameter as the fluid may be thick or flaky. When the patient is not anæsthetized for the operation it is often well to have a short flexible tube connect the trocar with the syringe. This should be fastened at both ends by silk ties so that it will not leak easily when pressure or suction is used. If the joint is to be washed out a definite amount of fluid is injected and the return measured in a sterilized measuring glass.

Dr. Murphy uses a formalin glycerine solution as follows:—Liquor formaldehyde 2% in glycerine, about ten drops of the formaldehyde to each ounce of glycerine.

This acts very well in infectious synovitis. But it should not be used in arthritis deformans nor in old chronic arthritis.

The tapping may be done with ethyl chlorid or novocaine adreneline solution, 1%. The solution should be prepared twenty-four hours before it is used (Murphy).

CHAPTER V

OPERATIVE TREATMENT IN CASES OF JOINT ANKYLOSIS

239. Partial Excision of the Shoulder for Ankylosis.—When there is ankylosis of the shoulder, a partial excision may be done. The operation is the same as that described here under Excision, with this exception:—that only enough of the bone is removed to allow free motion. The attachment of the infra spinatus and the deltoid should be carefully replaced and the arm held abducted ninety degrees and outwardly rotated ninety degrees. This position is maintained until the tone of the muscles is partly recovered by exercising in this position.

240. Excision of the Shoulder to Relieve Ankylosis.—When the shoulder is ankylosed an arthroplasty is the operation of choice. When there has been no disease for at least a year and if the condition was not originally tubercular, a partial incision may be done, allowing a loose joint with motion.

The operation is performed as described for excision, the head is removed, the sharp bony edges are removed and the arm placed in a position of ninety degrees outward rotation and ninety degrees of abduction in plaster. In three weeks a wire splint is used and exercise and motion are encouraged on this wire shelf splint for four months. The arm is held there in a position of ninety degrees of abduction and in a neutral position as to rotation until the shoulder muscles have acquired strength.

241. Arthroplasty for Ankylosis of the Shoulder.—Ankylosis may be bony, cartilaginous or fibrinous, it may be periarticular, ligamentous and capsular, or extra articular, that is, skin scars, tendons, fascia, nerves and arteries.

The form of ankylosis that exists will determine the treatment. A partial ankylosis at certain joints had better not be treated by an arthroplasty.

Age must be considered, also the general condition of the patient. When the ankylosis is bony, cartilaginous or fibrinous, arthroplasty is indicated. When the condition is periarticular or extra articular, it may be treated by capsulotomy, tendon elongation, excision of exostoses, etc.

Dr. Murphy lays stress on the following points:—The principles of asepsis to the finest detail are absolutely essential. One not familiar with the best surgical technique should avoid arthroplastic operations. The exposure of the joint must be generous and careful. The excision of the ankylosis must be complete. The contracted capsular ligaments and soft parts must be freed and if necessary lengthened. The normal

contour of the joint should be restored as nearly as possible. The operator should obtain a hyper-mobilization of the joint. The joint should be re-shaped to give stability. The inter-position of material to prevent reunion of the bone is necessary. The principle is to separate the bones and to interpose between them material to prevent bony union. The best material for this purpose is a pedicle flap composed of fat, muscle, fascia, or a combination of these.

When this is not possible, a transplantation is made of fat and fascia from the trochanter bursa region or from the fascia lata.

Materials such as ivory, celluloid, silver are not especially good. Materials that will not absorb or that absorb too slowly are not desirable.

During the operation the soft parts should be freely liberated. Attach the interposing flap to one bone only and cover it completely. Early motion, that is, active or passive, at the end of five to seven days is necessary with or without gas or gas oxygen.

Dr. Murphy records failures in arthroplasty as due to first, insufficient and defective exsection of the capsule and ligaments, second, insufficient interposition of fat and fascia between the separated bony surfaces, third, infection, fourth, the sensitiveness of pain on motion after operation.

Cases of primary tuberculosis and cases of recent infection that have subsided are not suitable cases for arthroplasty. In operation, in addition to the usual protection of the field of operation, after the skin and fat have been incised, towels should be clamped to the edges of the skin as an extra protection.

The patient lies on his back with a hard pillow or sand bag under the middle of the back and scapular to hold the shoulder off of the operating table. The operator stands on the side of the shoulder to be operated on.

Dr. Murphy uses an incision starting one-half inch below the acromion downward parallel to the fibers of the deltoid and one-half inch from its internal margin. The incision extends four inches downward through the skin and fat to the muscle. A transverse incision is made at right angles across the chest over the middle of the pectoralis major. The fibers of the deltoid are separated with a blunt dissector, the shoulder is rotated so that the bicipital groove comes in the line of incision. The blunt dissector is slid under the capsule in this groove. The capsule is cut on the director up to the acromion. The capsule is removed subperiosteally from the humerus as far as possible anteriorly and inward and outwardly and backward. Long silk sutures may be placed in the capsule to hold it retracted so that it may easily be recognized later on. The tendon of the biceps is lifted on a blunt dissector and displaced inward. The head of the humerus is separated from the glenoid with a curbed chisel and rounded, following the original anatomical lines as nearly as possible. A flap of fat, aponeurosis and muscle

is taken from the middle of the pectoralis major. Dr. Murphy advises a flap four and one-half inches by three and one-half inches out of the middle of the pectoralis major. The pedicle is left attached to the humerus and should be large enough to completely cover the bony surface. The head of the humerus is placed against the glenoid which has been smoothed. Over the head is stretched the fat, aponeurosis and muscle flap. These have been firmly sutured so that they will remain around the head. The capsule is now fastened to the humerus with interrupted chromic catgut sutures number 00, the muscles are attached with interrupted chromic catgut sutures number 00, the fat brought together with interrupted chromic catgut sutures, the skin with continuous chromic catgut sutures.

The under surface of the pectoralis major muscle is freed with a blunt dissector so that its fibers can be brought together wherever there is a gap in the tendon or muscle. The skin and fat are brought together with interrupted chromic catgut sutures. If the surgeon prefers to use the deltoid instead of the pectoral, an incision is made four inches long below the clavicle passing external to the deltoid fibers, between the deltoid and pectoral. This will expose the joint completely if the directions are followed as above. After freeing and shaping the bone, the deltoid is cut transversely and a piece interposed four inches wide between the head and the glenoid.

It has been suggested by Dr. Coville to remove a piece from the surgical neck and give motion at this point by interposition of the deltoid. This he reports as a practical operation.

After arthroplasty of the shoulder the weight of the arm should be lifted from the shoulder by a wire splint holding the arm in an abducted and outwardly rotated position (see figures 311, 312). Motion is begun with the arm still on the splint at the end of a week or ten days. When motion is possible without pain or discomfort it is increased and the splint lowered as soon as the shoulder is strong enough, which will not be before the fourth to the sixth week.

CHAPTER VI

OPERATION IN SUPPURATIVE CONDITIONS

242. Osteomyelitis.—In osteomyelitis an operation should be done as early as possible after making the diagnosis. In sub-acute cases, incision and drainage are all that is necessary. Whenever incising for abscess all the pockets should be opened and if the abscess is large, counter incisions are made at dependent portions. The pus pocket should be opened freely, wiped out with gauze, irrigated and wiped out again with gauze. Curetting should be avoided excepting for the removal of sinuses in the skin and in cases of sinuses it is often better to excise them. Perforated rubber tubing should be placed to drain the deepest portions of the pockets. The skin, fat and superficial muscle layers should be made to gap by means of gauze drains. At the end of ten days the gauze is removed and the tubes shortened. The tubes are gradually drawn out a little each day or two until not used. This method makes the repeated reapplication of drains and wicks unnecessary as the wound will gap of itself and close from the bottom if the surgeon has been careful to make large incisions.

Where the periosteum is found destroyed or the pus under the periosteal layer, the bone should be opened by means of a large drill or a small gouge. Where this is necessary, the incisions should be large and the counter incision should be made on the other side of the bone with a hole made in the bone a little above or below the hole on the opposite side (figure 66). These holes in the bone should open up the medullary cavity. They should alternate on one side and the other as far up and down as the disease is suspected. When the abscess is very great and the bone involvement is large a number of good sized holes should be made with a Burr drill or a curved gouge on both sides of the bone as shown in figure 67. The wound should be gaped widely;—the skin, fat and superficial muscle held open by large gauze drains. The tubes should reach from the surface to the deepest portions of the abscess cavity. Splints should always be applied to immobilize the limb. They should be placed so that they will not interfere with the dressing. In some instances it is better to apply plaster with large windows and ropes to give stability as shown in figures 459–460. The dressing should be done every day or twice a day, depending on the foul condition of the discharge. If the odor is excessive, chlorinated soda dressing should be used diluted, using it $^1/_2$, $^1/_3$, or $^1/_4$ the U. S. P. strength. The gauze drains should be left for at least ten days without being disturbed. When removed, granulations will be formed under them in such

a way as to keep the wound open without applying the drains. Irrigation may be used at the time of operation and the wound thoroughly wiped out with gauze afterward. No irrigation or probing or application of wicks will be necessary if the first drain is left in long enough. After the first ten days the tubes are shortened up gradually until they are not needed. See Carrell-Dakin technique, section 323.

In severe cases where the patient is unconscious or delirious, the bone should always be opened, three or four holes on either side made with a gauge or good sized Burr drill. In no case should the incision be made only on one side of the leg in severe cases. No tight packing should be used as this interferes with good drainage. Where sequestra have formed they should be removed. An x-ray should be taken whenever possible to determine the position of the disease (unless the case is urgent and an immediate x-ray is not obtainable).

In cases of long standing that are sub-acute at the first examination, where the bone is riddled with holes over an extremely long area, it is impossible often to remove the dead bone satisfactorily without removing all the bone. In these cases free incision down to the bone with frequent openings into the bone as described above, will allow the septic process to run its course and the sequestra to gradually separate. We have had some cases in which the lower third of both femora were riddled with holes and full of sequestra, the patient being in no condition for extensive operation, and yet not very ill. In these cases, however, if the surgeon had seen the patient in time an early operation would have prevented this extreme condition.

Sometimes it is necessary to close a large bone cavity which will not heal over. Where the process is distinctly septic no plastic operation should be done without first doing an operation to eliminate the septic condition. After that, part of the muscle may often be transferred over such a cavity after it is closed. In transferring a muscle over such a cavity it should be freely transplanted and held there without tension. The skin should be brought together over the muscle and the wound drained, as there is apt to be inflammatory disturbance.

Where sequestra are present it is always desirable to remove them as soon as they have separated and the involucrum is strong enough to act as a support. Sequestra may be superficial or in the medullary cavity or both. Where there is a persistent sinus and a sequestrum is present, pus will continue to form until the sequestrum is removed. Cases discharging several years where sequestrum is present may close in a few weeks after removal of the sequestrum.

In closing a bone cavity its edges may be chiselled clean and then the bone incised a short distance from one edge and parallel to it, the incision is carried down to the medulla, the incision in the bone is widened by prying it open and forcing the bone together, closing the old cavity. This is sometimes a satisfactory method of closing an old open bone cavity which has schlerosed edges.

243. Suppurative Conditions of the Shoulder.—In suppurative conditions about the shoulder joint an anterior incision through the deltoid fibers is a convenient route of approach. This will usually have to be supplemented by a posterior opening and sometimes by one in the axilla.

The joint is then washed out thoroughly before replacing the head, the abscess cavity is well wiped out with gauze and drains applied. The angles of the wound are held apart by rolls of gauze and tubes are placed to the depth of the suppurating cavities. If the disease is extensive or there is to be prolonged drainage or in cases where disease is extremely virulent, the operator should use large anterior and posterior incisions, keeping them well open with sponges in addition to the tubes inserted to the deep pockets.

Where there is extreme suppuration, a wire splint is preferable to a plaster unless the latter is applied with large windows and ropes as shown in figures 459, 460. See the Carrell-Dakin technique, section 323.

244. Excision of the Shoulder in Suppurative Conditions.—An excision of the shoulder may be indicated in certain cases of tuberculosis of the joint, in cases of extensive suppuration, for certain compound fractures, for irreducible dislocations sometimes, for ankylosis, etc.

The patient lies on his back, a sand bag or hard pillow is placed under the middle of the back to raise the shoulder well off of the operating table. The operator stands on the same side of the patient as the arm to be operated on; the field is protected in such a way that the arm and hand protected in a sterile sheet, may be manipulated into any position.

OPERATION

An incision is made one-half inch below the acromion extending downward parallel to the fibers of the deltoid and one-half inch to the outer side of its anterior inner margin. The incision is carried down four inches through the skin and fat to the muscle. The muscle fibers are next separated with a blunt instrument for the whole length of the incision. When the deltoid is retracted the operator will easily detect the bicipital groove with his finger and make an incision down to it by passing a director in the groove and cutting the capsule on the director up to the acromion.

If the excision is done to obtain ankylosis as in paralytic conditions or to obtain motion in cases of ankylosis either from injury, old disease, or fracture, the operator will not need to remove much bone. When, however, a great deal of bone must be removed on account of extensive disease, it will be necessary to detach some of the important muscles. The tendon of the biceps will be lifted from its groove on a blunt dissector and displaced inward, while the shoulder is rotated slowly inward and then outward during the process of freeing the capsule subperiosteally and also the attachment of the supra and infra spinatus and teres minor from the great tuberosity. The sub-scapularis teres major ex-

tend to the lesser tuberosity. This relieves at the same time the coraco-humeral ligament.

The head is now easily brought out of the wound and the necessary bone sawed off below the cartilage line. The axillary nerve and circumflex artery must be remembered. With care they will not come into view. In children the epiphyseal line should be preserved. After removing the necessary amount of bone, rongeurs are used to remove the sharp edges of the bone. The glenoid cavity is inspected and any diseased portion removed with a chisel, not with a curette.

Unless the disease is extremely slight, posterior drainage should be secured by a posterior opening. A pair of forceps is pushed through the tissues and made to protrude posteriorly. As they protrude, a one and one-half inch incision is made. If, however, the operation is done to obtain ankylosis, or to give motion, no drainage is necessary and the incision is closed completely.

The capsule which was detached is brought down to the humerus and sutured anteriorly and posteriorly with kangaroo or chromic catgut sutures number one, the muscles with chromic catgut sutures number 00, the fat also; the skin with continuous chromic catgut sutures number 00.

When drainage is necessary, the edges of the wound and the posterior incision are gaped by means of round wads of gauze, extending through the skin, fat and superficial muscle, tube drains are placed between and extend to the deepest portions of the wound. The arm should be held in an abducted position of not less than forty-five degrees, a large pad being placed under the elbow so that it may be held strapped up to allow good healing of the approximate soft tissues.

When the operation is done to obtain motion, the shoulder is held abducted ninety degrees and outwardly rotated sixty degrees on a wire splint or in plaster (see figures 314 to 317).

When the operation is done to obtain ankylosis as in certain paralytic conditions in order that the scapula muscles may be used to control the actions of the humerus, the arm is abducted about seventy degrees and held firmly (see Arthrodesis of the Shoulder).

245. Excision of the Scapula in Suppurative Conditions.—The patient lies on the opposite side of the body in a semi-prone position.

An incision is made over the posterior inner border of the scapula. This is joined by a second incision extending along the spine of the scapula to the tip of the acromion. An osteotome is used to remove the muscles subperiosteally from the inner border of the scapula extending upward along the upper border. The operator will next work from the inferior angle upward along the axillary border and the under side of the scapula. An osteotome is used to remove subperiosteally the trapezius, the supra and infra spinatus muscles working from within, outward. The acromion is chiselled through with an osteotome, freeing it from the spine of the scapula, the corracoid is freed at its base with an osteotome.

The supra scapular nerve should be avoided. Several small arteries will have to be ligated. When the inner and outer portions of the scapula are cleared from below upward, the scapula is lifted by its lower angle so that the anterior surfaces may be cleared of the sub-scapular muscle and serratus. All that remains after this are the attachments of the capsule and omohyoid muscle. The circumflex artery and transverse artery of the scapula may give some bleeding. The supra scapular nerve accompanies the transverse scapular artery. When possible the joint should be left.

The shock from this operation is very much less than that of removing the arm and blade. Whenever this limited operation may be done it is preferable for this reason to a complete removal of the arm and scapula. After removal of the scapula the joint may be attached to the clavicle. If the operation is done for disease, drainage will be necessary at the dependent portions of the incision. The edges of the incision may be opened or gaped with round gauze pads extending through the skin, fat, and superficial muscle. Tubes are placed between these to the deepest portion of the cavity.

The weight of the arm and shoulder is borne on a wire shoulder shelf (see figures 314 and 315), holding the arm abducted ninety degrees and outwardly rotated sixty degrees. Motion of the forearm, wrist and fingers is encouraged on the shelf after ten days. As the arm acquires strength, the shelf is lowered gradually and motions of the arm, active and passive, are encouraged without the shelf.

246. Methods and Principles of Drainage in Acute Non-tubercular Suppurative Joint Disease. Shoulder.—A small suppurative focus without virulence or active constitutional disturbance should be drained by a suitable incision wiped out with gauze, a tube placed to its deepest part and the soft tissues gaped with gauze.

When there is a great deal of constitutional disturbance drainage and counter drainage should always be the rule; if the bone is involved this should be opened and counter opened as shown (see figure 66). The pus cavities in the soft tissues should be wiped out. No extensive bone operation should be done otherwise. The bone should be drained with tubes to the remote portions and the muscle, fat, and skin gaped by gauze. These operations are done quickly and should not be prolonged, but efficient drainage and counter drainage should be established unhesitatingly. It is rarely necessary to do more at this time. If there is a marked sequestra formation this should be removed, but this had better not be done at the time of instituting drainage when the patient is nearly exhausted from an acute process. Any future operation made necessary should give good drainage and the removal of the sequestra if present and separated. See the Carrell-Dakin technique, section 323.

PART V—ELBOW

CHAPTER I

OPERATION FOR DEFORMITIES AND DISLOCATION OF THE ELBOW

247. Dislocations of the Elbow.—Dislocations of the elbow should be treated early. The bones may be reached by two lateral incisions each four inches long, or by a posterior incision internal to the olecranon five inches long with an external lateral just anterior to the condyle over the radial joint and extending upward four inches.

Dislocations of long standing are difficult to replace and may require an excision or arthroplasty. Each case will differ more or less but any case unreduced after six weeks is apt to have pretty substantial adhesions, rendering reduction difficult or impossible. When accurate replacement is impossible an arthroplasty or excision should be done without delay. The surgeon should avoid rough manipulation in attempting reduction as this will complicate the recovery from the operation which he adopts later.

If an open operation is necessary, the bones are brought into view and the tissues lifted from the bone. The soft tissues are separated en masse from the capsule fairly completely, keeping close to the bone subperiosteally as described under excision of the elbow, (see Excision, sections 269, 276). Instead of removing any bone the joint must be replaced accurately. The elbow is put up at right angles for ten days and then flexed to forty-five degrees from the right angle. Passive motion is begun gently after the first seven or ten days.

248. Manipulation of the Elbow Joint.—In manipulation for flexibility of the elbow, the motion in flexion and extension should be done with the forearm pronated and with the forearm supinated. The motions of the radius at the elbow should be tested in supination and in pronation with the elbow extended with the elbow flexed and with the elbow at right angle.

The flexion and extension of the wrist is manipulated in a pronated position and in a supinated position; the adduction and abduction of the wrist in a pronated position and in a supinated position and so on.

In manipulating for the flexibility of the fingers the wrist should be flexed, then extended for each manipulation. The manipulation should be done with the forearm pronated and repeated with it supinated.

The normal motion of the joint should be remembered. The stretching of the resisting tissues made gradually with a rhythmic stretching and relaxing, the force being applied gently and increased to a climax and

gradually decreased until there is complete relaxation. The joint is stretched and relaxed, the operator applying force in a gradually increasing manner until considerable force is applied and then relaxing until very slight force is used and finally relaxing entirely. In this manner a rhythmic extension and flexion is kept up. No rough or forcible extension without a gradually increasing or gradually decreasing force should be employed. By this method a minimum amount of trauma is caused. Forcible pumping motions are to be avoided. A joint that at first will seem almost impossible to move will often give way. Before any extensive operation, a fairly normal action in all normal directions should be obtained.

249. Plaster of Paris for the Elbow.—A plaster of Paris at the elbow may be put on with the arm straight or with the elbow flexed at any angle. The palm of the hand and the space to the outer side of the second metacarpal should be well padded so that the plaster may be carried between the thumb and index finger over the second metacarpal but not in such a way as to interfere with the motion of the thumb and index finger or the other fingers. This hand portion of plaster will maintain the desired pronation or supination of the forearm. The wrist and elbow should be very well padded, but the plaster should fit the humerus from end to end and the forearm from end to end.

CHAPTER II

MUSCLE AND TENDON OPERATIONS. MUSCLE AND TENDON TRANSPLANTATION

250. Transplantation of the Triceps for Paralysis of the Biceps.— —When the biceps is paralyzed and the triceps is good and strong, the outer half of this muscle may be transplanted into the paralyzed biceps as follows.

OPERATION

An incision is made over the back of the upper arm starting at the junction of the middle and upper third extending downward over the olecranon. The skin and fat are retracted exposing the outer third of the tendon of the triceps. This is divided and dissected from the bone to the above olecranon, here it is expanded into half of the triceps muscle. The outer half of triceps is dissected up to a little above the middle of the arm. An incision is now made over the front and middle of the biceps down to this muscle, this is split with a blunt dissector and a tunnel made extending backward to the posterior incision. A tendon carrier or clamp is passed backward through the tunnel, grasps the tendon of the triceps bringing it forward through the opening of the biceps. Silk is now quilted up one side and down the other of the triceps tendon. An incision is now made over the front of the elbow extending over the inner side of the biceps tendon and to its fascial expansion below. The incision should expose the lower end of the biceps muscle as well. A subcutaneous tunnel is now made below the fat connecting the two anterior incisions. A tendon carrier is now passed upward from the lower to the upper incision and brings with it the silk and tricep tendon. The silk is now quilted into the bicep tendon and fascia and the lower end of the biceps muscle sutured to the tricep, the elbow being flexed twenty degrees beyond a right angle.

FIG. 363.—Humerus drilled, leader of silk worm-gut placed in drill eye.

The deep tissues and fat are sutured with interrupted catgut sutures, the skin with chromic catgut number 00. A plaster of Paris bandage is applied holding the elbow flexed slightly more than a right angle.

CHAPTER III

OPERATION IN CASES OF TOTAL OR PARTIAL PARALYSIS

251. Flail Condition of the Elbow.—When a flail condition of the elbow exists, silk ligaments may be used to hold the joint at right angles or an arthrodesis may be done, otherwise it will be necessary to use a brace to hold the elbow at right angles in order that the hand may be used. An apparatus is often sufficient and very comfortable.

252. Silk Ligament at the Elbow.—If silk ligaments are to be used they are inserted as described for the ankle (see also figures 363 to 368).

253. Fascia Transplantation for Flail Condition of the Elbow.—

OPERATION

An incision is made three inches long over the anterior lower third of the humerus, and extending through the skin and fat. What remains of the atrophied fibers of the biceps and brachealus anticus fibers are separated by a blunt dissector and retracted exposing the bone. A large hole is drilled in the humerus through the anterior third of the bone and a silk wormgut guide (figure 363), passed through the

Fig. 364.—Silk wormgut drawn through the humerus. Drill used to draw silk subcutaneously to the forearm.

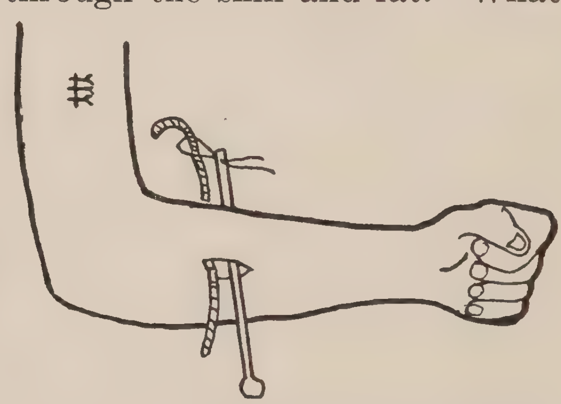

Fig. 365.—Drill passed through the ulna. Silk from the humerus threaded through the silk wormgut leader.

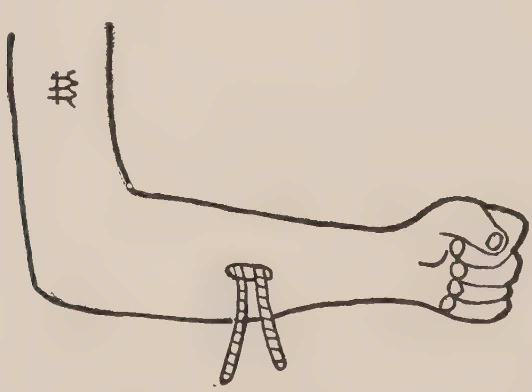

Fig. 366.—Silk protruded from the forearm, one has passed through the ulna, the other comes from the humerus.

Fig. 367.—Diagram of silk ligaments in paralysis at the elbow.

bone by means of the drill which should be made with an eye. A second incision is made four inches long over the middle of the upper half of the forearm through the skin and subcutaneous fat. The atrophied muscles are easily separated and the ulnar bone exposed and drilled. A silk wormgut guide is passed through the bone.

Removal of fascia from the fascia lata

An incision five or six inches long is made on the middle and outer aspect of the thigh down to the fascia lata; by retracting the skin and fat which is very elastic, a piece of fascia broader and longer than the incision may be obtained. The amount necessary should be carefully measured by a probe and an extra two inches allowed. The fascia removed is slit at each end and its edges rolled (figure 294). A tunnel is made in the subcutaneous fat connecting the two arm incisions, the fascia passed through this and its ends (figure 295), passed through the bone above; the lower ends through the bone below. The ends are overlapped and sutured with interrupted chromic catgut sutures number 00 (figure 296). If the operator prefers, these ends are sutured to the deep fascia or to silk passed through the bone (figure 297). The elbow should be flexed fifteen degrees beyond what is desired so that the fascia will hold it flexed slightly more than right angles. There will be a stretching of about twenty-five degrees in time.

FIG. 368.—Incisions closed.

After treatment

A posterior wire splint or plaster of Paris bandage is applied holding the elbow in sufficient flexion to take all tension off of the fascia. A large roll of loose cotton is placed over the front of the arm and arranged as in tendon operation on the leg. The original position should be maintained eight weeks. If a plaster of Paris bandage is used the front half may be removed and a gauze bandage applied to hold on the posterior half. In this way the wound may be inspected readily. After six weeks the weight of the forearm is allowed to pull on the fascia from five to fifteen minutes twice a day in increasing doses. Then later four times increasing every third day, until the forearm is carried without apparatus two hours at a time. After this the strain of holding the forearm is increased rapidly.

254. Operation on the Skin for a Flail Elbow, (Mr. Jones' operation).—The patient lies on his back, the extended arm is placed on a table.

An incision is made diamond shaped through the skin and fat and subcutaneous tissue over the front of the arm, the skin removed and sutured so that the upper and lower angles of the diamond come in contact

with each other, holding the arm at flexion twenty degrees more than right angles.

Before incising the skin, a heavy piece of silk is passed through the skin (see figures 359, 360), at the selected upper angle and another at the selected lower angle of the diamond. These are brought together so that the operator may judge the amount of stretching that will take place when the weight of the forearm is allowed to come on the skin. When this is determined, a diamond shaped piece of skin is marked out with its upper end on the anterior aspect of the lower third of the upper arm and the lower angle of the diamond will be in the upper third of the forearm. These points will have been determined by the silk inserted in the skin and made to hold the arm in the desired position before incising the skin. This will decide the proper distance between the upper

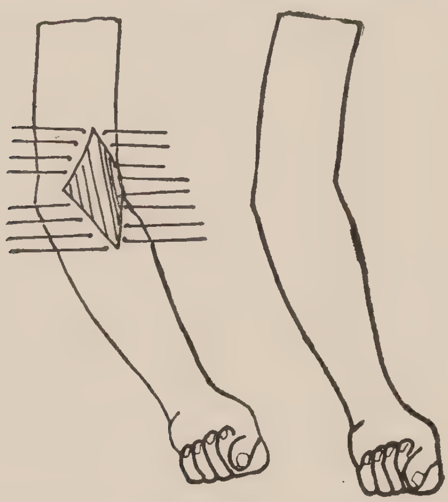

Fig. 369.—Diamond shaped skin incision; the outer edges are approximated and then the inner edges approximated.

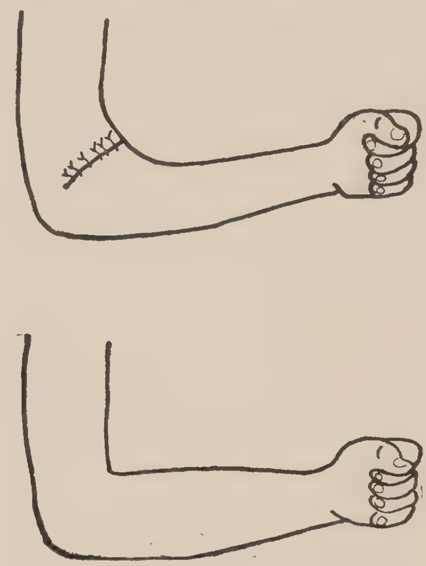

Fig. 370.—Edges of the diamond are brought together.

and lower ends of the diamond. The test will also determine the shape of the diamond. The operator will remove less skin than is required. More is then removed to hold the elbow flexed twenty degrees beyond right angle.

After treatment

A plaster of Paris bandage or posterior wire splint will relieve tension on the skin until it is healed. This should remain for eight weeks. It is then removed fifteen minutes twice daily, later four times a day and increased every three days until the patient has the motion of the forearm without the splint for two hours twice daily; after that the progress is more rapid.

255. Arthrodesis of a Flail Elbow.—If a rubber bandage and tourniquet are to be used, the surgeon should have the tourniquet put on carefully and not too tight and have it removed as early as possible. A towel should be put under the tourniquet.

The patient lies on his back, the arm across his thorax. The operator stands on the same side as the arm to be operated on. A posterior inci-

sion, four inches long is made, starting two inches above the tip of the olecranon and extending vertically downward to the triceps. The fibers of the triceps are separated carefully and a subperiosteal dissection is made, exposing the sides and back of the humerus and of the ulna. The joint capsule is opened, the olecranon is chiselled off with an osteotome through the middle of the sigmoid cavity and the end displaced upwards; the joint is denuded of cartilage and roughened.

The trochlea surface may be split from below upwards, the edge of the osteotome being parallel to the intracondylar line. The broadening of the trochlea surface and the roughening of the bone in consequence favors ankylosis. The olecranon is held in place by suturing the periosteum or by silver wire. The separated olecranon may be fastened to the humerus by silk or silver wire preventing extension of the arm. The deep tissues are carefully brought together with interrupted chromic catgut sutures number 00, the triceps likewise, the subcutaneous fat with interrupted chromic catgut sutures number 00, the skin with continuous chromic catgut sutures number 00. The arm should be put up extended fifteen degrees or twenty degrees from a right angle position and held here by a firm plaster of Paris bandage with windows for the inspection of the incisions. In most instances apparatus is preferable to an operation when a flail elbow exists. It is well to remember that the surgeon is not always gratified when attempting to get ankylosis at the elbow, though under other circumstances a stiff elbow is not uncommon.

CHAPTER IV

INCISION, PUNCTURE AND ARTHROTOMY

256. Arthrotomy.—A knowledge of the important routes of approach to the joints will facilitate any joint exploration, the removal of foreign bodies, the repair of traumatic conditions, the adjustment of difficult fractures, the reduction of old and difficult dislocations, the mobilization of joints where motion is partially or totally lost, and the stiffening of the joint as in certain paralytic conditions, the treatment and drainage of suppurative conditions; a knowledge of the important routes of approach to the joint is very important. For each case, the operator will select the incision best suited for the individual condition. Each joint will be considered separately in other chapters.

In all operations on the joints, the incision should be made down to the synovial cavity. All bleeding should be stopped and the synovial membrane carefully opened. The joint structures should be tampered with as little as possible, the synovial membrane brought together carefully and the layers over it closed in order not to disturb the function of the periarticular tissues. Unnecessary separation of the tissue layers is to be avoided. Tendons should be left in their sheath. Any ligaments that must be cut should be loosened periosteally, in order that they may be readily replaced. Early motion should be the rule, gentle at first, and gradually increased. Joint operations should never be hastily considered and should be avoided by anyone not familiar with the best surgical technique.

In exploratory operations at the elbow, erasions, excisions, or arthrodesis, or dislocations, for draining suppurative conditions, either the posterior or the external-lateral supplemented at the same time by an internal incision are the routes preferred.

The operator stands on the side of the arm to be operated upon. The arm is placed across the patient's thorax. The incision is made four inches long starting two inches above the tip of the olecranon and slightly to the outer side of the middle line. The fibers of the triceps are divided carefully in the line of the incision. The dissection is carried down to the bone and through the periosteum. By means of a long handled osteotome or a sharp periosteum elevator the periosteum is removed, working to the outer side, clearing the condyle from above downward.

257. Posterior Incision (see figure 371).—The posterior incision is made vertically to the outer side of the olecranon or to the inner side. The outer incision is preferable for excision, arthroplasty, fractures of the olecranon, of the outer condyle, and exploratory operations on the

joint. For dislocations, the incision may be made to the inner side of the olecranon and be supplemented by an external incision over the condyle slightly anterior. Some surgeons prefer two lateral incisions for dislocations and for arthroplasty. The anterior incision is a more hazardous route than the lateral or the posterior and is rarely necessary. The anterior route follows the outer edge of the biceps tendon down to the capsule.

The posterior incision begins two inches above the olecranon and extends vertically downward about four inches. It is made to the outer side of the olecranon. The dissection is carried down to the bone. The periosteum is incised and the tissues lifted with it. A long handled osteotome is used for this purpose or a sharp periosteal elevator with a good handle. The periosteum is started at the upper end of the incision and raised, working downward until the lower end of the incision is reached; the operator then works at that end and goes upward and outward, raising the periosteum from the bone until the outer condyle is cleared. The surgeon should avoid roughness in forcing up the periosteum. The work at this point is largely one of diligence. The outer condyle is cleared first then the inner condyle (see Excision, section 276).

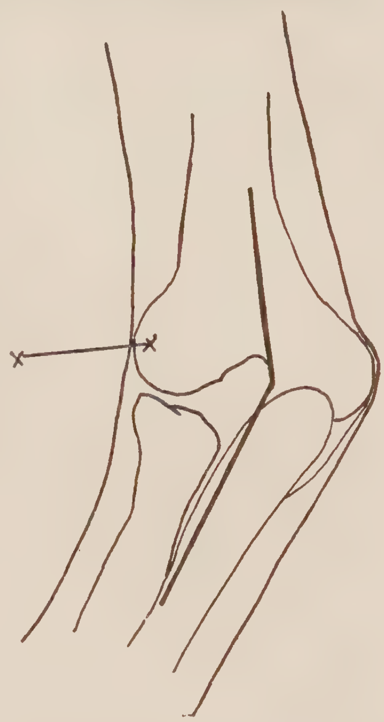

Fig. 371. — Posterior incision along the inner side of the olecranon extending four inches above and four inches below the joint.

258. External Lateral Incision (see figure 372).—This incision is made parallel to the bone extending over the head of the radius and upward five inches, just anterior to the condyle. The dissection is made carefully down to the bone, the radial joint opened if necessary and the periosteum raised from the condyle starting over the head of the radius working upward and forward until the upper end of the incision is reached. The operator raises the periosteum here, then works gradually downward and then upward lifting all the tissues subperiosteally; after clearing the bone anteriorly he may clear off the periosteum posteriorly, depending on the exposure necessary.

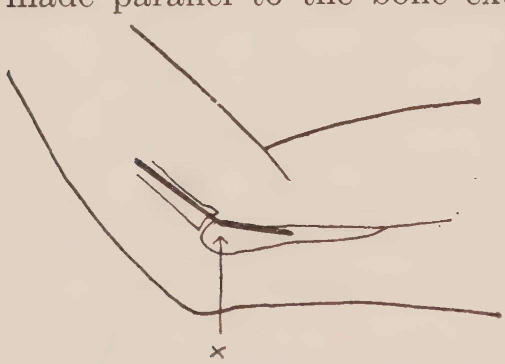

Fig. 372.—External lateral incision over the condyle and head of the radius.

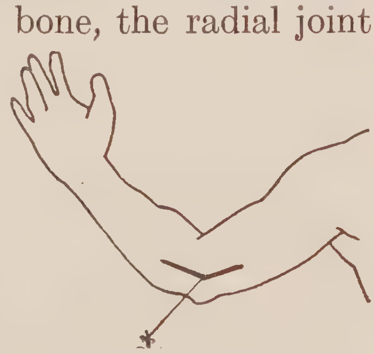

Fig. 373.—Internal lateral incision just posterior to the internal condyle.

259. Internal Lateral Incision (see figure 373).—This incision is made four inches long extending two inches above and two inches below

the condyle and slightly posterior to it. The position of the ulnar nerve must be remembered. The periosteum is lifted under it so that it is not seen during the process of lifting the periosteum. The operator clears the condyle as far as necessary anteriorly and then posteriorly.

260. Anterior Incision for Reaching the Elbow Joint.—This incision is rarely necessary and is not as practical as the posterior or lateral. It is made to the outer side of the tendon of the biceps, following down through the bicipital fascia. A blunt dissector is used to separate the tissue below this until the capsule is reached (see figure 374).

Fig. 374. — Anterior incision along the outer side of the bicipital fascia.

261. Operations for Fractures at the Elbow.—Operations, when necessary, for fractures at the elbow, should be done as early as possible. In all compound fractures where the condition of the patient allows, the compound wound should be opened up and thoroughly cleansed. If opening up the compound wound does not give a good approach for treatment of the fracture, one of the above incisions may be utilized in addition. Quantities of irrigation with sterile water or sterile salt solution together with wiping out of the wound with gauze strips will usually be sufficient to give a first intention healing. The operator will have to select the incision best suited for the individual fracture. It is important to remember that there will be better healing with a long vertical incision than with a transverse incision. The tissues should not be separated in layers but be kept together on either side of the incision. No method should be adopted that will increase the amount of repair necessary or interfere unduly with the circulation. Plenty of room is, however, necessary. If the swelling is great, it will be difficult to put the fracture up at an acute angle to the desirable position which assures the proper adjustment of the fragments. It is often better for this reason not to operate until the swelling has subsided; in the meantime the elbow is immobilized at right angles.

The necessity of immediate operation in fractures about the joints depends, as in other fractures, on the acuteness of the local and general reaction. When these do not contra indicate immediate operation, certain fractures about the joints may require treatment by the open method. Among these are fractures of the patella, fractures of the olecranon and certain fractures of the surgical neck of the humerus and certain fractures of the neck of the femur, all compound fractures, even when the protrusion of the bone has been extremely slight, all fractures that cannot be reduced by manipulation or in which the correction cannot be maintained or where apposition is impossible,

many fractures combined with dislocation, articular fractures with pieces locking or limiting the joint action.

Where there is a great deal of trauma and in multiple fractures and in cases where there is a great deal of shock all that can be done is to immobilize the parts until a favorable time for operation. In selecting a suitable time for operation the surgeon must remember that when it is found necessary to operate on a fracture if there is no immediate contra indication, the sooner it is done the better. Where there is tremendous swelling one should always wait. All cases should be operated on that show no union after three months of good treatment.

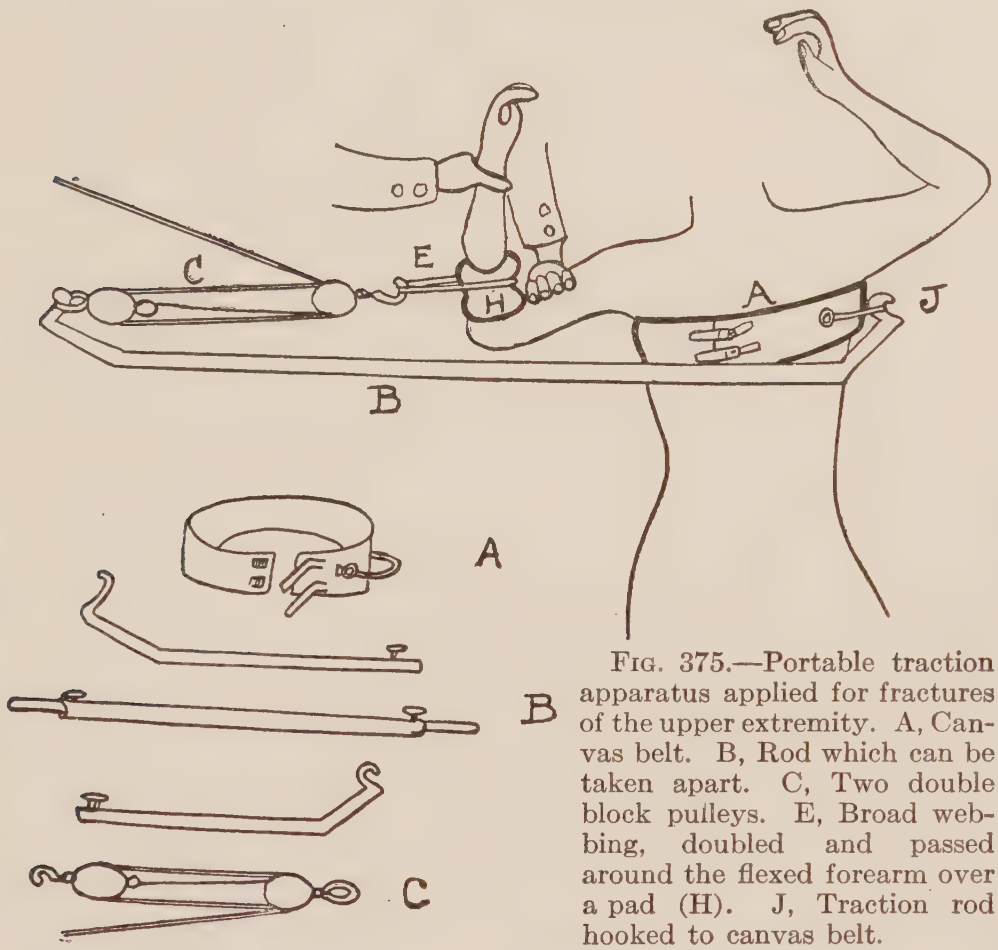

Fig. 375.—Portable traction apparatus applied for fractures of the upper extremity. A, Canvas belt. B, Rod which can be taken apart. C, Two double block pulleys. E, Broad webbing, doubled and passed around the flexed forearm over a pad (H). J, Traction rod hooked to canvas belt.

262. A Traction Apparatus for Fractures at the Elbow (see figures 375 to 379).

Note.—(This apparatus may be used for fractures of the shoulder and fractures of the shaft of the humerus.)

In fractures and dislocations of the elbow and the lower end of the humerus, when the displacement is very marked, replacement is difficult without a good deal of injury to the tissues.

The following apparatus has been found of service in that it minimizes the trauma of reduction. It makes the alignment of a fracture a matter of regulated precision. The apparatus may be used in open operations and in reducing a fracture or dislocation without incision; it may be used in fractures of the elbow, humerus and shoulder whenever traction is

an advantage with or without incision to adjust the fractures to wire, bone plate, or bone graft. The apparatus consists of a canvas belt (see figure A), two double two inch block pulleys (see figure C), and a rod five feet long and three-fourths of an inch in diameter (see figure B), bent at both ends with a hook at each tip. This rod is made in three sections so that it may be easily carried.

For use without incision (See figure 375.)

A canvas belt is placed around the patient's thorax high up under the axilla. This serves to hold one end of the rod making traction on the arm as follows:— the patient is anæsthetized and lies on the operating table or bed, the traction rod is placed over the front of the chest (see figure B). One end is hooked to the canvas belt at the side opposite the fracture (see figure J). The other end extends nearly four feet from the side of the operating table. A heavy pad (see figure H) consisting of one or two pillow cases folded, is placed over the upper end of the forearm. Around this is placed a webbing strap, doubled (see figure E). Pulleys are attached from the free end of the traction rod to the webbing around the upper end of the flexed forearm. Traction is then applied with the elbow flexed at right angles. When the overlapping is corrected, traction is maintained while the surgeon moves the fragments forward or back or laterally, as the case requires. The traction can be increased or diminished easily and gradually without jarring the parts. The perfect control is effected by two two-inch double block pulleys (see figure C). Single block pulleys are not satisfactory. The surgeon manipulates the bones while he directs the assistant managing the traction. A pull of one inch on the rope will move the fragments one-fourth of an inch.

Fig. 376.—1 a, 1 b, transverse supracondylar fractures. 2a, 2b, oblique fracture of the shaft. 3a, 3b, fracture of the neck.

When the fracture or dislocation is adjusted, the webbing on the upper forearm is moved to the wrist while the elbow is greased or powdered if necessary. The webbing is then replaced over its pad and the final adjustment made by applying traction again. The elbow is then flexed to an acute angle or put in a position selected by the surgeon and held there by him while the retentive dressing is applied. When traction is released the surgeon maintains his hold on the arm, the webbing on the forearm of the patient is removed by sliding it up over the wrist and hand to the forearm of the surgeon or it may be unbuckled and

removed if no longer needed. This apparatus, in connection with a traction machine for operations on the leg, was devised about twelve years ago by the writer. It should be noted that while making traction the forearm strap must not slide off the pad nor the elbow allowed to become acutely flexed.

Use of the apparatus for open operations on fractures or dislocation of the elbow (See figures 377, 378.)

NOTE.—(This apparatus can be used in fractures of the shoulder and shaft.)

This apparatus is used as described above when an open operation is necessary. In order not to interfere with the asepsis of the operation, the traction rod is placed across the operating table covered with a pillow and the patient placed over the pillow. This places the rod behind

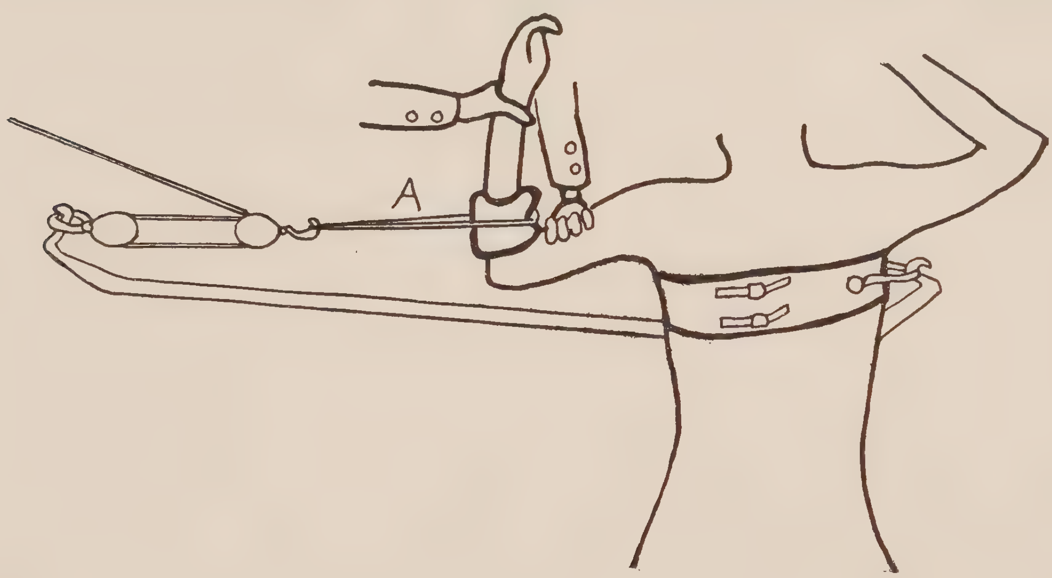

FIG. 377.—Represents the apparatus ready to be covered with sterile sheets for open operations, the arm, arm pad and webbing (A) being sterilized.

the patient instead of in front, its end protruding at the side of the operating table nearly four feet. One end of the traction belt is hooked to the canvas belt as described above. The arm and hand are cleaned up, made sterile, and protected as usual with sterile sheets. The folded pillow case or small sheet which is to be used as a pad on the forearm is sterilized beforehand. The webbing for traction on the forearm is also sterilized. This webbing should extend at least a foot from the elbow after being doubled and looped over the padded forearm. The loop of webbing is next attached to the pulley and covered by a sterile sheet pinned to it and clamped so that the webbing touching the pulley and the pulley cannot be exposed during the application and removal of traction while operating. This sterile sheet protection allows the operator to remove completely and re-apply the loop of webbing from the forearm without disturbing the asepsis. The traction rod and patient are protected by sterile sheets (see figure 378). Traction may be applied and released during the operation without exposure of any nonsterile material.

Where the trauma, due to the accident, has been great, it is better in the case of certain fractures to wait from five to seven days to allow the swelling to subside before replacing the fracture. The fracture is immobilized during the interval. It is of advantage in these cases, where the displacement is great, in replacing the fracture, to cause as little trauma and consequent after swelling as possible, following the reduction. This apparatus is especially valuable for this purpose. When the fragments are finally adjusted, this method is sufficiently free from trauma to cause little and in some cases practically no additional swelling following its use.

Most fractures of the elbow, excepting fractures of the olecranon, are best held with the elbow at an acute angle. This position is not always a desirable one at the time of injury on account of the swelling. Overlapping bones, with lateral and antero-posterior displacement at the

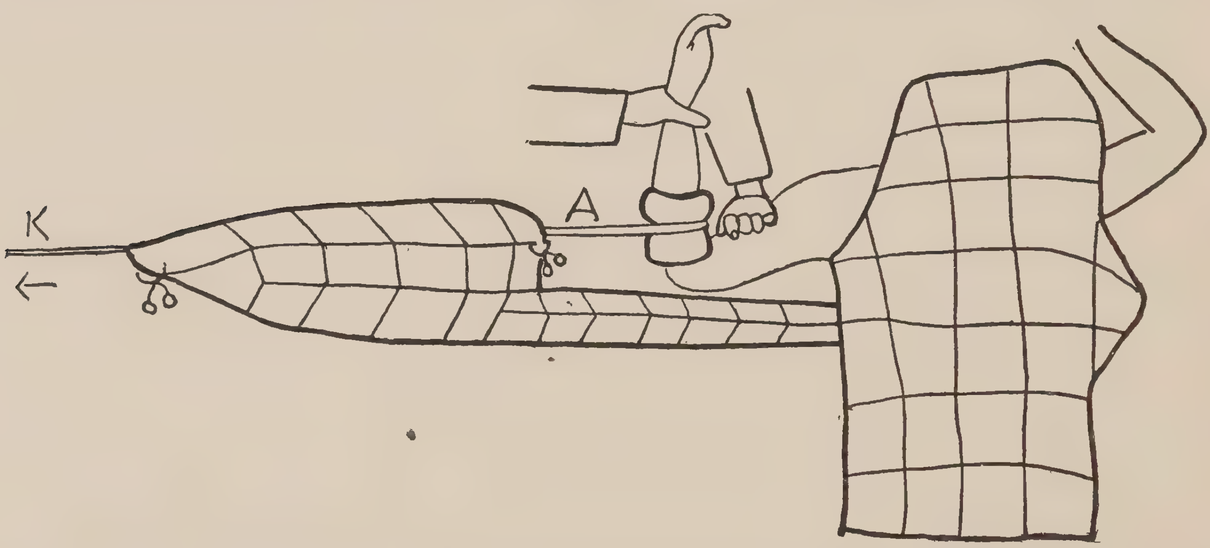

Fig. 378.—Represents the apparatus covered with sterile sheets, represented by cross lines. Traction at (K) is made by a non-sterile assistant. The sterilized webbing (A) can be removed from the arm and replaced.

elbow, are difficult to replace without causing a good deal of swelling which, if it occurs, may make it necessary to abandon the acute flexion position so desirable in many elbow fractures.

By means of this apparatus, used when the swelling has largely subsided, there need be very little additional swelling following reduction, making the use of the acutely flexed position comparatively free from danger and free from acute pain. The adjustment is under perfect control making very perfect reduction possible.

Methods of treating the individual fracture cannot be considered in a limited space like this. The writer has described the routes of approach to the different joints and the technique of these. This will enable the surgeon from his knowledge of fractures to select the route best adapted for the individual treatment required and when necessary two or more incisions may be used. A knowledge of the technique will enable the surgeon to work rapidly in reaching the fracture on which he expects to spend time.

263. A Method of Treating Overlapping Fractures.—Where the bones overlap, an excellent method of treatment is one suggested to the writer many years ago by Dr. Edward Martin of Philadelphia. In the operation when the surgeon has reached the fracture the bone is freed. A tough tape or webbing is used ten or twelve feet long, sterilized. The two ends of the tape are tied together, a loop of the tape is placed over the distal end of the bone. The other end of the tape is thrown over the foot of the operating table, a thirty-five pound weight is attached to this by an assistant. In about five minutes the bones will be found to be separated at least one inch. The weight is then held up by a non-sterile assistant, the tape taken off of the end of the bone and clamped to the sheet on the operating table, so that it will not slip away while the surgeon works on the fracture. When the muscles are in fairly good tone or the overlapping of bone has been great, it will be found that the bones will overlap again in four or five minutes. A reapplication of the tape will separate the bones again for the same length of time. The end of the lower bone should not be cut or freshened until all other procedures are done which require separation of the bone. When these have all been done the end of the bone over which the tape has been placed is freshened. After this the tape should not be placed on the end of the bone unless it is very necessary, but the two ends allowed to come together and held by a clamp until the operation is complete.

Very bad overlapping fractures have been treated in this way in fresh cases without the necessity of shortening the bone. In old fractures no more bone need be removed than is required by the conical condition of the ends of the bone.

Fig. 379.—These fractures may be treated by the traction apparatus (see figure 377), with or without open incision.

264. Fractures of Long Standing Still Ununited or United with Deformity, Preventing Function.—In fractures of long standing where there is a mild infection conservative treatment should be tried first. When this has been tried free drainage should be established and at the same time the ends of the bone freshened up slightly. Unless the infection is marked, in many of these cases when the suppuration disappears, union has also taken place. In any case where there has been infection, no plastic operation should be used until the infection has been entirely absent for at least nine months, a year is safer. Where the infection is very mild and of long standing, during the process of treatment the patient may be allowed to walk on the other leg if the local reaction is not too great. Sometimes he may walk a little on the affected leg.

It is of advantage in certain cases to use a Thomas splint to take some of the weight off of the affected leg, the patient being allowed to bear weight on the ball of the foot, the splint taking all the weight off of the heel. Where the x-ray shows conical ends of the bones it is practically useless to expect union without surgical interference. If there is much swelling in fractures about the elbow, the arm may need to be held at right angles until it has subsided, but as a rule the acute flexion assures correction of the displaced fragments. When they are not readily replaced, an open incision is made to the bone. The surgeon chooses the incision best adapted to the fracture and goes down through the periosteum exposing the bone subperiosteally and adjusting the fragments when the bone is well exposed.

265. Irreducible Dislocation and in Multiple Fractures of the Elbow.—After severe injuries with multiple fractures at the elbow and in irreducible dislocations of the elbow, it is often necessary to do an excision or an arthroplasty in those cases that do not yield to the usual methods of conservative treatment. See sections 289 and 292.

266. Overlapping Fractures of Both Bones of the Forearm.—When there is a fracture of both bones of the forearm, it is often possible to obtain good apposition without an incision. However, the overlapping fracture is a very difficult one to reduce and to hold after reduction. When treated by the open method, it requires the greatest care and precision. One bone is apt to displace while the other is being adjusted. To avoid this, the method of reduction is described with some detail.

When a satisfactory reduction is not obtained shortly after the accident, an incision is almost always necessary. If the fracture is fairly recent, that is to say, within three weeks, good union may be expected after reduction. An incision is made for each bone separately, the skin and fat separated in one layer. It is made at the side of the arm in order not to be pressed on by the splints. The overlapping bones should be treated as described elsewhere, for overlapping fractures. The tape placed on the ends of the bone will readily separate them with a minimum amount of trauma. Each bone should be placed in position. Following this, sutures are placed through the skin and fat without closing the wound. These sutures are not tied. The long suture ends are clamped and held aside so that the fractures may be readily inspected. One assistant holds the wrist, and another the elbow, while the surgeon takes a final view of one fracture, and then the other. If necessary, the surgeon should re-adjust the fracture before closing the incisions, the arm is held steadily by the two assistants, while the sutures are being tied and other superficial sutures are placed without moving the arm. They do not relax their hold until the splints and bandages are applied. Sterile sheet wadding is placed evenly around the arm. The anterior and posterior splints are applied without disturbing the fracture. An internal angular splint is applied or else a plaster of Paris

bandage to immobilize the elbow. The plaster should be put around the two forearm splints but later half of it cut away below the splints, This allows the elbow and the splints to be inspected. After inspection, the elbow is flexed again, and the two splints slide into place in the plaster and are bandaged there. In judging the tension of the splints the surgeon presses the splints together at the points where the adhesive is placed. If the adhesive will wrinkle slightly it is not too tight. The splints should fit the arm perfectly at the side and have ten to twelve thicknesses of sheet wadding.

No foreign substance as a rule need be used to hold the bones, unless the fracture is of long standing, in which case it is better to use a bone graft than bone plates for one bone at least. The bones are chiselled apart and the ends fastened. Where the tape method of treating overlapping fractures is used it is not necessary to shorten the bone unless the fracture is old and the x-ray shows that the ends are conical. (See sections 262, 263.) Following the operation, the fracture should be viewed at the end of five days and then every second or third day by removing the posterior splint; any tendency to bowing should be adjusted by small pads. Otherwise the fracture is treated like a simple fracture of both bones.

267. Fractures of the Olecranon.—When a fracture of the olecranon is treated by a splint holding the arm straight, it may heal without surgical interference. It should be operated on early if the fragments cannot be easily replaced or if they have been separated a week or more. If left any length of time the fragments are apt to heal and the ends will not fit as well. A "U" shaped incision or a long posterior incision is used to the outer side of the fracture through the skin and fat. These are retracted and the incision carried down to the bone in the median line. Any clot is wiped out. The fractured ends are brought together and fitted, then the bone is drilled. The drill is inserted through one fragment; as the tip protrudes the fragments are put together. The drill point is made to mark the point of entry in the second fragment. The drill is then withdrawn from the first fragment and is used at the marked point to drill the second fragment. Kangaroo, phospho bronze or silver wire may be used to fasten the fragments together perferably at first. The arm is put up straight and flexed slightly at the end of ten days, the flexion is increased gradually, until it reaches a right angle in three weeks. At the end of six weeks if it will not flex forty-five degrees beyond the right angle, it should be manipulated gently under an anæsthetic and placed in an acute angle and held by adhesive or a figure of eight bandage for a few days. As long as the thumb can reach the shoulder, the arm may be allowed more extension. Should it become difficult to reach the shoulder, with the thumb, the adhesive is temporarily shortened preventing extension beyond a point from which this flexion is easy.

268. Tapping the Elbow Joint.—The most scrupulous aseptic precautions are necessary both as to the preparation and the protection of the field of the operation.

The elbow is flexed at right angles, the trocar enters the joint just anterior to the external condyle above the head of the radius. The process is rendered easier when there is much swelling. An assistant or the operator presses on the joint anteriorly to make the joint as full as possible at the point of tapping. The elbow being fully flexed, the joint may be tapped above the olecranon. Local anæsthesia may be sufficient but the use of gas or primary anæsthesis is preferable if any injections are to be made.

When there is much effusion it is not difficult to reach the joint. The skin is drawn to the side so that the hole in the skin and muscle will be out of line when the needle is removed. If fluid is to be drawn, and other solutions are to replace it, the amounts should be carefully measured. Two good graduated metal syringes are very useful. All of their parts should be tested beforehand. The trocar is made to enter the joint and then is connected with the syringe. As little air as possible should enter the joint. The trocar should be of large diameter as the fluid may be thick or flaky. When the patient is not anæsthetized for the operation it is often well to have a short flexible tube connect the trocar with the syringe. This should be fastened at both ends by silk ties so that it will not leak easily when pressure or suction is used. If the joint is to be washed out a definite amount of fluid is injected and the return measured in a sterilized measuring glass.

Dr. Murphy uses a formalin glycerine solution as follows:—Liquor formaldehyde 2% in glycerine, about ten drops of the formaldehyde to each ounce of glycerine.

This acts very well in infectious synovitis, but it should not be used in arthritis deformans nor in chronic arthritis.

The tapping may be done with ethyl chlorid or novocaine adreneline solution 1%. The solution should be prepared twenty-four hours before it is used (Murphy).

CHAPTER V

OPERATION IN CASES OF ANKYLOSIS OF THE ELBOW

269. Excision or Ankylosis for the Elbow.—Ankylosis of the elbow may be congenital or as a result of trauma or suppurative arthritis. These may be of bone origin, articular, or periarticular, causing thickening or scar formation. Ankylosis may be caused by injuries and fractures, irreducible fractures or dislocations of the humero-radial or of the humero-ulnar joint.

Excision or arthroplasty is indicated for ankylosis from whatever cause which does not yield to conservative measures, provided no disease has existed for over a year. When tuberculosis has existed, an arthroplasty is not as good an operation as an excision; neither should be done unless some muscular power is present. In some cases when there is power this may develop and an operation done when the muscle seems strong enough for future function.

For ankylosis of the radial joint, an excision of the head of the radius is possible through a very small incision. The bone is removed by a small osteotome and a fat and fascia flap or a muscular flap turned in between the bones. See section 276.

270. Synostosis at the Elbow.—A synostosis of the bones of the forearm, either congenital or acquired, is often difficult to treat. The operator should make long incisions that will gape easily. The dissection should be made to the bone carefully without separating the layers on either side of the incision. In this way a minimum amount of injury is possible to the tendons and other important structures and the condition will be readily exposed and dealt with without injury to the soft tissues.

271. Arthroplasty for Ankylosis at the Elbow.—Ankylosis may be bony, cartilaginous or fibrinous, it may be periarticular, ligamentous and capsular, or extra articular, that is, skin scars, tendons, fascia, nerves and arteries.

The form of ankylosis that exists will determine the treatment. A partial ankylosis at certain points had better not be treated by an arthroplasty.

Age must be considered, also the general condition of the patient. When the ankylosis is bony, cartilaginous or fibrinous, arthroplasty is indicated. When the condition is periarticular or extra articular, it may be treated by capsulotomy, tendon elongation, excision of exostosies, etc.

Dr. Murphy lays stress on the following points:—The principles of asepsis to the finest detail are absolutely essential. One not familiar

with the best surgical technique should avoid arthroplastic operations. The exposure of the joint must be generous and complete. The contracted capsular ligaments and soft parts must be freed and if necessary lengthened. The normal contour of the joint should be restored as near as possible. The operator should obtain a hyper-mobilization of the joint. The joint should be re-shaped to give stability. The interposition of material to prevent reunion of the bone is necessary.

The principle is to separate the bones and to interpose between them material to prevent ankylosis. The best material for this purpose is the human pedicle composed of fat, muscle, fascia or a combination of these.

When this is not possible, a transplantation is made of fat and fascia from the trochanter bursa region or from the fascia lata.

Material such as ivory, celluloid, silver are not good. Materials that will not absorb or that absorb too slowly are not desirable.

During the operation the soft parts should be freely liberated. Attach the interposing flap to one bone only and cover it completely. Early motion, that is, at the end of five to seven days is necessary with or without gas or gas and oxygen.

Dr. Murphy records failures in arthroplasty as due to first, insufficient and defective exsection of the capsule and ligaments, second, insufficient interposition of fat and fascia between the separated bony surfaces, third, infection, fourth, the sensitiveness to pain or motion after operation.

Cases of primary tuberculois and cases of recent infection that have subsided are not suitable cases for arthroplasty. In operation, in addition to the usual protection of the field of operation, after the skin and fat have been incised, towels should be clamped to the edges of the skin as an extra protection.

272. Arthroplasty for Ankylosis at the Elbow.—The patient lies on his back, the operator stands on the side of the arm to be operated on. The shoulder is adducted and flexed and inwardly rotated.

An incision is made six inches long with its middle at the olecranon. Two lateral are preferable, one may be sufficient. In any extensive injury which has caused the ankylosis, the operator may either stick very closely to the bone and avoid seeing the ulnar nerve or he may find the ulnar nerve and free it. Whenever the scar tissue does not extend to the bone, and is not great, it is better to stick close to the bone and not see the nerve. After freeing the humerus and ulna as described in these pages for an Excision (see Operation for Excision), the bones are separated as there described, the olecranon will have to be sacrificed as it will interfere with the plastic operation. After shaping the humerus and ulna so that they conform to the normal joint outlines, a flap is taken from the uponurosis of the supinator longus and interposed between the bones or the operator may prefer to use a portion of the fat and fascia on the inner side of the arm. In either case the base of the flap is directed upward. The flap should reach completely across the

joint and be wide enough to cover it. If there is an ankylosis as is often the case, between the radius and the lesser sigmoid cavity, a portion of the bone must be removed here and muscle interposed. When the ulnar nerve has been found to be fastened down firmly with scar tissue to the bone and when any extensive dissection has been necessary to free it, it should be replaced in its groove at the end of the operation well surrounded with fat. The arm should be held in a right angle position for about a week and motion begun after that a little twice a day. In ten days apparatus is removed and a sling worn. Where the operation has been carefully done, it is usually necessary to gain flexion rather than extension.

In the after treatment the operator should work to gain flexion first. When the extended and abducted thumb can touch the humerus, this motion should be preserved while motion in extension is being encouraged.

The further treatment depends on exercises, and physical therapy such as baking and massage.

273. Overhead Sling for the Arm Following Operation.—The arm may be held vertically or horizontally by an overhead sling. A long stick of wood like a broom handle is attached in a vertical position to the post at the foot of the bed. The upper end should be about five or six feet from the floor, another is placed at the middle of the head of the bed in the same way. A light window cord is drawn tightly between the ends of the two sticks, the arm is held off of the bed by a bandage attached to the rope. The suspended arm should be placed in a comfortable position.

CHAPTER VI

OPERATION FOR SUPPURATIVE CONDITIONS

274. Suppurative Conditions, about the Elbow.—A posterior incision either side of the olecranon, avoiding the ulnar nerve, combined with a lateral, just anterior to the external condyle, to drain the radial joint will be sufficient for the majority of extensive suppurative conditions.

At the elbow it is important in extensive joint suppuration to open anteriorly as well as posteriorly and not forget the radial joint. See Carrell-Dakin Technique, section 323.

The principles otherwise are the same as those laid down for other joints.

275. Osteomyelitis.—In osteomyelitis an operation should be done as early as possible after making the diagnosis. In sub-acute cases, incision and drainage are all that is necessary. Whenever incising for abscess all the pockets should be opened and if the abscess is large, counter incisions are made at dependent portions. The pus pocket should be opened freely, wiped out with gauze, irrigated and wiped out again with gauze. Curetting should be avoided excepting for the removal of sinuses in the skin and in cases of sinuses it is often better to excise them. Perforated rubber tubing should be placed to drain the deepest portion of each pocket. The skin, fat and superficial muscle layers should be made to gap by means of gauze drains. At the end of ten days the gauze is removed and the tubes shortened. The tubes are gradually drawn out a little each day or two until not used. This method makes the repeated reapplication of drains and wicks unnecessary as the wound will gap of itself and close from the bottom if the surgeon has been careful to make large incisions.

Where the periosteum is found destroyed or there is pus under the periosteal layer, the bone should be opened by means of a large drill or a small gouge. Where this is necessary, the incisions should be large and a counter incision should be made on the other side of the bone with a hole made in the bone a little above or below the hole on the opposite side (figure 66). These holes in the bone should open up the medullary cavity. They should alternate on one side and the other as far up and down as the disease is suspected. When the abscess is very great and the bone involvement is large a number of good sized holes should be made with a Burr drill or a curved gouge on both sides of the bone as shown in figure 67. The wound should be gaped widely;—the skin, fat and superficial muscle held wide open by large gauze drains. The tubes should reach from the surface to the deepest portions of the abscess cavity. Splints should always be applied to immobilize the limb.

They should be placed so that they will not interfere with the dressing. In some instances it is better to apply a plaster with large windows and ropes to give stability as shown in figures 450 to 460. The dressings should be done every day or twice a day, depending on the foul condition of the discharge. If the odor is excessive chlorinated soda dressing should be used diluted, $^1/_2$, $^1/_3$ or $^1/_4$ the U. S. P. strength. The gauze drains should remain for at least ten days without being disturbed. When removed granulations will be formed under them in such a way as to keep the wound open without applying drains. Irrigation may be used at the time of the operation and the wound thoroughly wiped out with gauze afterwards. No irrigation or probing or application of wicks will be necessary if the first drains are left in long enough. After the first ten days the tubes are shortened gradually until they are not needed.

In severe cases where the patient is unconscious or delirious the bone should always be opened, three or four holes on either side made with a good sized Burr drill or gouge. In severe cases the incision should be made on both sides of the leg always. No tight packing should be used as this interferes with good drainage. Where sequestra have formed they should be removed. An x-ray should be taken whenever possible to determine the position of the disease (unless the case is urgent and an immediate x-ray is not obtainable).

In cases of long standing that are sub-acute at the time of first examination, where the bone is riddled with holes over an extremely long area, it is impossible often to remove the dead bone satisfactorily without removing all the bone. In these cases free incision down to the bone with frequent openings into the bone as described above, will allow the infection to run its course and the sequestra to gradually separate. We have had some cases in which the lower third of both femora were riddled with holes and full of sequestra, the patient being in no condition for extensive operation, and yet not very ill. In these cases, however, if the surgeon had seen the patient in time an early operation would have prevented this extreme condition.

Sometimes it is necessary to close a large open bone cavity which will not heal over. Where the process is distinctly infected no plastic operation should be done without first doing an operation to eliminate the infection. After that, part of the muscle may often be transferred over such a cavity to close it. In transferring a muscle over such a cavity it should be freely transplanted and held there without tension. The skin should be brought together over the muscle and the wound drained.

Where sequestra are present it is always desirable to remove them as soon as they have separated and the involucrum is strong enough to act as a support. Sequestra may be superficial or in the medullary cavity or both. Where there is a persistent sinus and a sequestrum is present, pus will continue to form until the sequestrum is removed. Cases

discharging several years where a sequestrum is present may close in a few weeks after removal of the sequestrum.

To close a bone cavity its edges may be chiselled clean, then the bone incised a short distance from one edge and parallel to it, the incision is carried down to the medulla, the incision in the bone is widened by prying it open and forcing the bone together and closing the old cavity. This is sometimes a satisfactory method of closing an old open bone cavity which has sclerosed edges. See Carrell-Dakin technique, section 323.

276. Excision of the Elbow for Suppuration. (See Fig. 371.)—An incision is made starting two or three inches above the olecranon and to its outer side extending vertically downward two or three inches below it. The skin and fat are separated and the triceps muscle fibers separated down to the bone. The periosteum is incised and peeled off the outer condyle of the humerus above and downward to the olecranon and off of this and the ulna extending outward so that the whole of the external condyle is exposed subperiosteally. After this, the internal condyle is cleared in the same way, a long handled osteotome being used for the purpose. The ulnar nerve must be avoided; it is perfectly safe if the operator will stick below the periosteum, it will not come into view. The olecranon is chiselled off the joint opened. The humerus is cleared next anteriorly and laterally. In case of ankylosis it is sometimes easier to clear the ulna and radius. When the joint is separated it is easy to keep up the subperiosteal dissection by bringing the humerus out of the wound and then the ulna and radius. The diseased bone is removed with a saw just at the upper part of the condyles removing one-half inch from the condyles (see figure 380) and just through the base of the head of the radius removing the head of the radius and the ulna at the same level (see figure 380); this should be removed with a saw. Rongeurs are used to remove the sharp edge of the bone, any further disease is cut out with a chisel, cutting the healthy bone around it. Enough bone should be removed with the saw to allow very free mobility of the joint. The disease in the soft tissues is dissected out completely. The triceps and all the tissues have remained unexposed between the periosteum and the skin. They are now brought together and carefully sutured. The periosteum and the muscles, the fat and the skin layer by layer, covering the end of the radius with muscle to prevent adhesions.

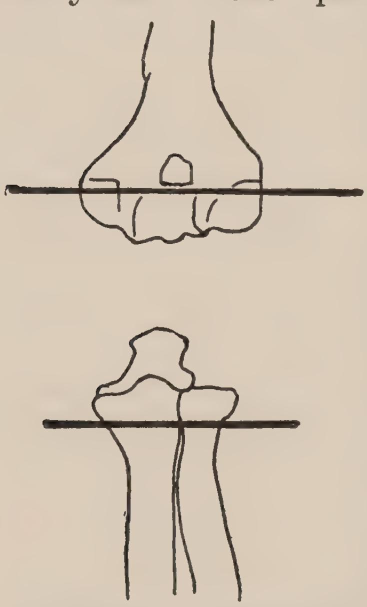

Fig. 380. — Excision of the elbow, line marking the bone to be removed.

A puncture is made one inch long over the other side of the joint where the head of the radius was situated. This and a similar internal poste-

rior drainage point is usually sufficient in suppurative cases. The triceps will repair and be ready for future usefulness. The elbow is immobilized at right angles in plaster and the elbow may be suspended by a bandage to an overhead trolley, held there after operation. Later the elbow is acutely flexed. Pronation and supination and flexion are begun a little on the tenth day.

The arm should be allowed to flex but no extension beyond a right angle allowed until the muscles are strong enough to flex completely and extend easily to a right angled position.

277. Methods and Principles of Drainage in Acute Non-tubercular Suppurative Joint Disease. Elbow.—A small suppurative focus without virulence or active constitutional disturbance should be drained by a suitable incision wiped out with gauze, a tube placed to its deepest part and the soft tissues gaped with gauze. See section 323.

When there is a great deal of constitutional disturbance drainage and counter drainage should always be the rule; if the bone is involved this should be opened and counter opened (figure 66). The pus cavities in the soft tissues should be wiped out. No extensive bone operation should be done otherwise. The bone should be drained with tubes to the remote portions and the muscle, fat and skin gaped by gauze. These operations are done quickly and should not be prolonged, but efficient drainage and counter drainage should be established unhesitatingly. It is rarely necessary to do more at this time. If there is a marked sequestra formation this should be removed, but this had better not be done at the time of instituting drainage when the patient is nearly exhausted from an acute process. Any future operation made necessary should give good drainage and the removal of the sequestra if present and separated. The joint should be immobilized.

Any extensive non-tubercular suppurative bone disease about the elbow should be drained by a posterior and an antero-lateral external incision or by both of these and an internal lateral. If the patient is very ill and the abscess in the bone not easily located, large incisions are made to the bone and the bone drilled or not, as the case demands. The operation should be done very rapidly and good drainage established. For chronic suppuration or tuberculosis an excision is often indicated when conservative treatment has been unsuccessful.

PART VI—WRIST AND HAND

CHAPTER I

DEFORMITIES OF THE WRIST AND HAND

278. Operation for Madelung's Deformity.—An incision is made down to the bones of the carpus and projecting bone, the bones are exposed subperiosteally and enough of the carpus removed to allow the prominent bone to slip into place. The incisions are closed, the tendons retracted without disturbing them in the tissues.

A plaster and then a leather should be worn for about three months. This apparatus should allow the use of the fingers and hand but immobilize the wrist. The carpal joints beyond the wrist will increase in motion and make up for some of the restriction of motion which follows the operation.

279. Club Hand Operation.—When the deformity is due to absence of one of the bones of the forearm, a longitudinal incision is made over the remaining bone; the latter is split to receive the carpus. The carpus is prepared by slanting its lateral edges without narrowing it any more than is absolutely necessary. The bone and carpus are sutured and the tissue closed, the arm and hand being held in a plaster allowing the use of the fingers and hand. As these grow strong the support is gradually omitted after the third or fourth month. The carpus usually becomes very flexible allowing about one-third of the normal wrist flexion and extension. When both bones are present bony union by graft or splitting the radius is usually necessary to prevent recurrence of the deformity of the wrist.

280. Contracted Wrist and Finger Operation.—When the wrist and fingers are contracted if there is no disease present, the wrist may be manipulated so that it will extend, flex, adduct and abduct in a pronated, in a supinated position, and halfway between the two. It is sometimes necessary to lengthen the tendons of the contracted muscles as described in these pages. Where there is much scar tissue in the palm of the hand or wrist it may be necessary to excise this and to transplant a flap from the abdomen. To do this a sterile cloth is cut the size of the flap desired. The hand is placed over the abdomen in a comfortable position without strain on the shoulder, elbow or wrist. The site of the skin is selected, the cloth pattern is laid over it and the outline marked one-half inch larger than is necessary all around. The flap is dissected up, leaving two broad attachments. The hand is placed in position and the flap adjusted but not finally sutured. The hand is withdrawn.

If necessary one of the broad attachments may be cut away or they may both be left. The skin edges from which the flap was cut are now lifted with the fat and freed well from four to six inches separating the fat from the underlying fascia. This will allow the skin to be brought together without tension under the lifted flap. Mattress sutures over gauze or over rubber tubing are used to hold the edges without tension; the skin and fat are sutured. The hand is now placed in position over this and the flap sutured to it as planned. The upper arm and forearm are separated from the body by sterile towels and padding, a swathe is placed over this leaving the hand and flap exposed, adhesive plaster is placed outside the swathe about three strips three inches broad, this will hold the arm in place.

To return to the hand, before the dressing is applied any surfaces of skin that come in contact, should be separated by an intervening layer of cotton cloth, sterilized. This is placed between the palm and the skin of the abdomen. The flap should be sutured carefully allowing no granulating areas excepting at the pedicle attachment. If the flap is large its edges may be brought together making a cylinder, where it leaves the abdomen. This may be done before finally placing the hand in position. In eight days the hand with the graft is cut away from the abdomen. The abdominal skin will be healed excepting a small opening which is closed. The skin edges are freshened before suture.

When the contracture is of the finger only, this may be congenital or acquired. A rectangular palmar skin flap is usually better than a V-shaped one though sometimes a V-shaped one is preferable. When it is necessary to place a wolf graft from the arm or leg, a square end skin incision is preferable. The skin flap slides down and the tendon stretched or lengthened. After operation for flexion of the finger, the wrist should be held flexed by means of a dorsal wire or aluminium splint on the hand and forearm and the fingers held extended. The splint is used constantly for three weeks and part of each day, after that for at least six months.

281. Manipulation of the Finger and Wrist Joints.—The flexion and extension of the wrist are manipulated in a pronated position and in a supinated position; the adduction and abduction of the wrist in a pronated position and so on.

In manipulating for flexibility of the fingers, the wrist should be flexed, then extended for each manipulation. The manipulation should be done with the forearm pronated and repeated with it supinated.

The normal motion of the joint should be remembered. The stretching of the resisting tissues made gradually with a rhythmic stretching and relaxing, the force being applied gently and increased to a climax and gradually decreased until there is complete relaxation. The joint is stretched and relaxed, the operator applying force in a gradually increasing manner until considerable force is applied and then relaxing

until very slight force is used and finally relaxing entirely. In this manner a rhythmic extension and flexion are kept up. No rough or forcible extension without a gradually increasing or gradually decreasing force should be employed. By this method a minimum amount of trauma is caused. Forcible pumping motions are to be avoided. A joint that at first will seem almost impossible to move will often yield. Before any extensive muscle or tendon operation, a fairly normal action in all directions should be obtained.

CHAPTER II

MUSCLE AND TENDON OPERATIONS. MUSCLE AND TENDON TRANSPLANTATION

Fig. 381.—Silk quilted into the tendon at the finger tip.

282. Silk Elongation for Cut or Short Tendons in the Finger.—When a tendon in the finger is cut or hopelessly involved in scar contractures it is often simpler to elongate with silk as described below rather than to dissect up the tissues and separate out the tendon from a large mass of scar tissue to which it will readily adhere again. This is especially the case when the tendon has been cut and injured in several places.

OPERATION

A small incision is made three-quarters to one inch long on the palmar surface of the finger (see figure 381), a number fourteen silk is quilted into the fibrous sheath about the tendon. A second incision is made in the front of the wrist above the carpal bones, a long probe or director with a hole in its end is passed from the finger to the wrist subcutaneously. A silk guide is passed through the eye in the probe and the silk withdrawn with this guide or directly with the probe. The number fourteen silk now reaches the wrist. The incision in the finger is closed with interrupted chromic catgut number 00 or with horse hair.

Fig. 382.—Silk quilted into the tendon is drawn to the lower forearm by means of a tendon carrier.

The flexor tendons in the wrist are exposed and the proper one located by pulling on the others which extend to the fingers. The silk is now quilted into the tendon (see figures 382, 383), which is cut away so that it will be free from its distal attachment, unless one of the free tendons to one of the other fingers is used. In this instance the two fingers must be expected to flex simultaneously.

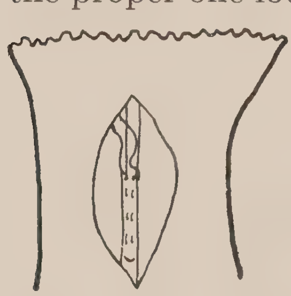

Fig. 383.—Silk quilted into the tendon at the wrist and then tied to the silk from the finger.

The deep fascia is brought together with interrupted chromic catgut number 00, the subcutaneous fat with interrupted chromic catgut number 00, the skin with continuous chromic catgut number 00.

The finger and wrist are immobilized for two weeks, after that slight motion is allowed under supervision of the surgeon for three weeks more. After that the splints are removed and the muscles trained.

283. Operation to give Power to Supinate the Forearm in Cases of Paralysis of the Supinators. Tubby Operation. Transplantation of the Pronator-radii-teres to give Power of Supination.—The transplantation of the pronator-radii-teres is done for a persistent or marked tendency to continuous pronation often present in spastic cerebral paralysis and sometimes in infantile paralysis and obstetrical cases. Dr. Tubby advised the transplantation of the pronator-radii-teres in these cases converting the muscle into a supinator.

Fig. 384. — Incision for transplantation of the pronator-radii-teres when the forearm is pronated and in paralysis of the supinators.

Fig. 385.—Tissues and superficial muscles retracted to show the oblique fibers of the pronator-radii-teres.

An esmark and tourniquet, if used, should be applied carefully by an experienced person. The arm is bandaged with a rubber bandage from the finger tips to the middle of the upper arm. Here a towel is applied under the tourniquet which should be applied with great care and not too tightly. As soon as the important part of the operation is over, the tourniquet should be removed as tourniquets on the arm are undesirable for any length of time.

OPERATION ON THE RIGHT ARM

The operator stands on the outer side of the forearm which is held supinated. An incision is made (figure 384) on the outer third of the forearm down to the muscle layer, the main portion of the muscular fibers of the pronator-radii-teres extend across the arm above the junction of the upper and middle thirds (see figure 385). The tendinous portion is largely in the middle portion of the forearm. To find the muscle easily, the incision should be made in the outer third of the forearm with its middle corresponding to the junction of the upper and middle thirds. When carried down to the muscle layer, the incision should expose the supinator longus (figures 386 to 388); this is retracted outward, exposing the pronator-radii-teres, extending obliquely from the internal condyle to the middle of the radius. It is the only oblique muscle here. If the operator experiences any difficulty in finding the pronator-radii-

teres, he may expose the anterior surface of the radius. If he traces this upward, he will come across the oblique attachment of the pronator. In dissecting this attachment from the bone, the operator should work from above downward. The fibrinous attachment is intimately connected with the periosteum which is very much coarsened; in dissecting the insertion subperiosteally from above downward it is possible

Fig. 386. — Retractors expose the oblique muscle fibres of the pronator-radii-teres.

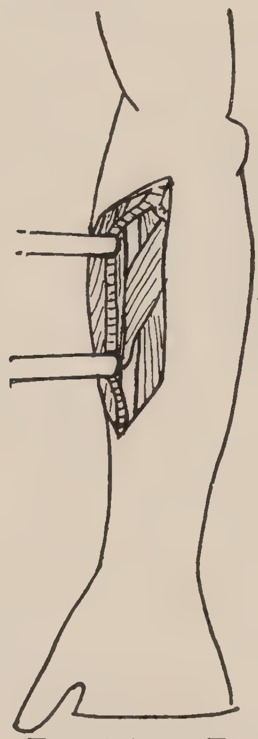

Fig. 387. — Further retraction exposing the attachment of the pronator-radii-teres along the radius.

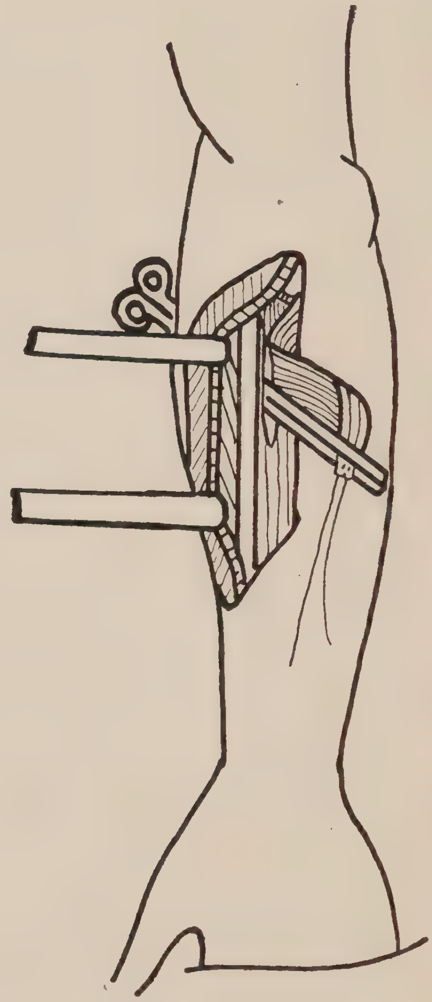

Fig. 388.—Tendon carrier or clamp passing forward to grasp the tendon and draw it out of the posterior incision.

to obtain a very much longer tendon which will reach easily around the radius (see figures 389 to 394). The flexor longus pollicis and sublimis digitorum lie under the pronator-radii-teres. The pronator tendon is dissected up, a blunt dissector is used to separate the interosseous membrane between the bones close to the radius.

As the blunt dissector comes to the surface posteriorly, a small incision is made over it allowing it to protrude through the skin. A long clamp or tendon carrier is entered here and protrudes through the anterior incision passing to the inner side of the radius. It grasps the tendon of the pronator and draws it out posteriorly, a towel is placed above and another below the muscle while silk is quilted up one side and down the other of the tendon, as described under transplantation of the peroneii. A long clamp is now inserted into the anterior incision extending backward along the outer side of the radius. It protrudes through the posterior incision, grasps the silk and draws it forward followed by the

tendon on the outer side of the radius. The new insertion of the pronator-radii-teres is selected slightly above its previous insertion. The bone is drilled here (figure 390), the forearm being placed in a position one-half way between pronation and supination. The bone is drilled antero-posteriorly (see figures 391, 392). Two ends of silkworm gut are pulled through this drill hole to be used as a leader in introducing the silk from the tendon. The loop of silkworm gut should protrude anteriorly (see figure 394). The silk from the tendon is drawn through (see figure 394), and protrudes at the posterior incision. A tendon carrier or long carrier is passed into the anterior incision to the inner side of the radii and protrudes from the posterior incision. The silk is grasped by it and pulled forward. One end is passed under the silk where it enters the drill hole. The arm should be

Fig. 389.—The pronator-radii-teres protrudes backward and is then drawn forward to the outer side of the radius.

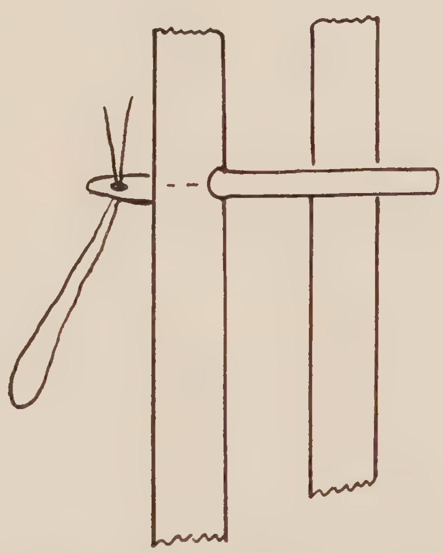

Fig. 390.—Diagram of the radius and ulna, the former being pieced by a drill. A silk wormgut leader is being passed through the drill eye.

Fig. 391.—The silk from the tendon extends to the inner side then posterior and enters the bone posteriorly when the arm is pronated.

supinated forcibly before tying the silk. The muscle should hold the arm in a supinated position. An assistant maintains this position while the muscle is drawn tight and the silk tied three times. The knot is pressed flat. The subcutaneous tissues are brought together with interrupted chromic catgut sutures number 00, and the skin with continuous chromic catgut sutures number 00. A plaster of Paris bandage is applied (see figure 395) with the forearm held in a supinated position. The thumb and fingers should be perfectly free, a small plaster rope being applied over the palm of the hand which is well padded. The plaster should be split on both sides of the arm and windows cut over each incision to allow inspection of the wound without removing the apparatus. If there is much swelling the plaster may be loosened at either side or the front half removed. The patient

is kept in bed at least five days. Moving about increases the swelling. Where the surgeon is careful and gentle in the manipulation of the muscles and subcutaneous tissues, the swelling will be correspondingly less. The wounds should be dressed on the fifth and seventh days with gauze wet with alcohol. After that the wounds are dressed every second or fourth day with a dry dressing. The supinated position of the forearm should be maintained from four to six months. After that a light apparatus, such as a plaster or leather or wire splint (figure 401), is worn maintaining extreme supination

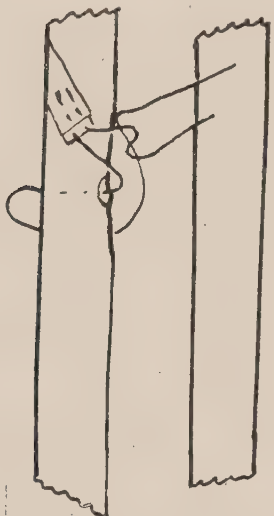

FIG. 392.—As the arm is supinated the silk from the tendon enters the bone from the inner side, between the bones, and is tied as shown in this, and the next figure.

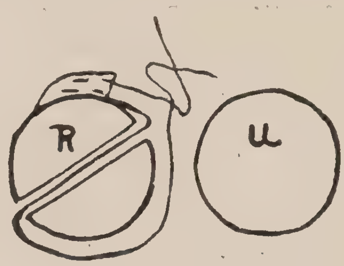

FIG. 393.—R, Radius. U, Ulna. When the forearm is supinated the silk enters the bone at the inner side of the radius, protrudes outward, extending posteriorly and comes up to the inner side where it is tied.

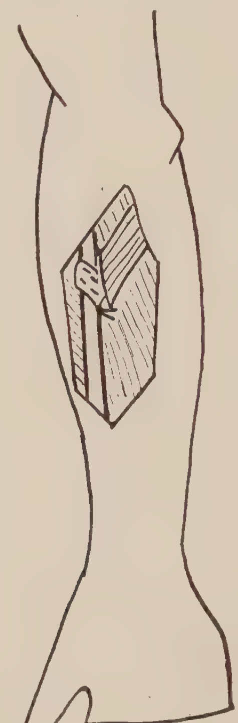

FIG. 394.—Pronator-radii-teres held to the bone by silk.

for six or eight hours each day. Muscle training and daily stretching should be begun after the sixth week and continued for a year at least. The use of the extremely supinated position daily by means of a splint will vary according to the control of the arm and the tendency to pronate. This should be watched and the splint used accordingly.

284. Muscle Transplantation in the Forearm.—In transplantation for paralysis of the extensors of the wrist and fingers the different methods are given below. The operator will have to select the muscles spared in the individual case. A gray or grayish pink muscle will not be suitable for transplantation. A pinkish red should not be selected if a better one is available. The wrist flexors and extensors may be used for paralysis of the extensors of the fingers or for the paralysis of the flexors of the finger as described below. The strong muscles must often be lengthened or stretched out before it is safe to transplant. This must be determined by the individual case.

285. Operation for Contracted or Short Extensors of the Wrist and Fingers; Tendon Lengthening.—The patient lies on his back, the arm rests on a table, the operator stands on one side, the assistant on the other.

An incision is made three or four inches long over the middle third of

the forearm down to the muscles. The tendons are carefully lifted with a blunt dissector to assure the operator of the exact function of each and to which finger it extends. The lengthening should be done in the

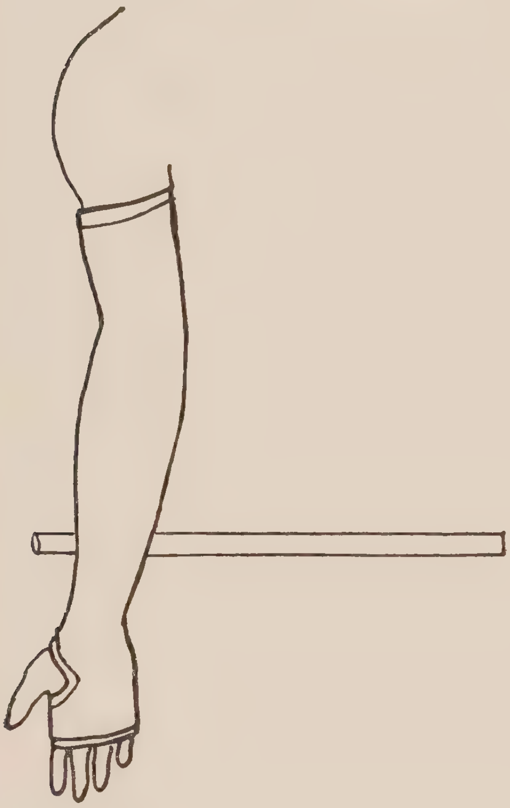

FIG. 395.—Plaster of Paris with the elbow straight, the forearm supinated and a long piece of wood incorporated in the plaster at right angles to the arm extending across the patient's lap and preventing pronation of the arm.

FIG. 396.—The tendon to be lengthened.

FIG. 397.—The tendon cut either straight across or zigzag (see figure 399).

FIG. 398.—Tendon lengthened.

FIG. 399.—Zig-zag tenotomy.

tendon on the belly of the muscle according to one of the methods described under tendon lengthening. (See section 126). Each tendon should be noted previous to operation and the required amount of shortening or lengthening estimated for each tendon. At the time of operation the surgeon pulls on the tendon and recognizes it from its action on the wrist or finger. Each one is lengthened as planned before operation (see figures 396 to 399). The deep tissues are brought together with interrupted chromic catgut sutures number 00, the subcutaneous tissues with interrupted chromic catgut sutures number 00, the skin with continuous chromic catgut sutures number 00. A small dressing, four or five layers of gauze,

one inch wide are placed on the wound and extending one-half inch beyond the incision at each end. Sterile sheet wadding is applied over this. A wire or aluminum splint (see figures 400 to 402) or plaster of Paris bandage is applied holding the elbow at right angles and the fingers and wrist flexed after an operation on the extensors and holding the wrist and fingers extended after an operation on the flexors.

In cases with deformity that is extreme and of long standing, when the flexors are lengthened the extensors must be shortened and vice versa.

Fig. 400. — Plaster applied allowing the use of the fingers, or extended holding wrist flexed or extended with the elbow flexed when pronation and supination must be controlled.

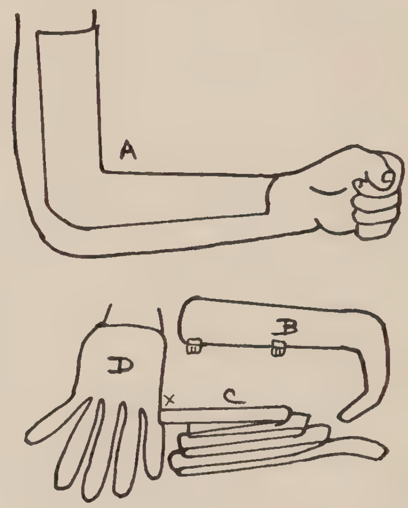

Fig. 402.—Aluminum splint to hold the wrist and fingers flexed. A, Elbow portion which is strapped on with tapes. B, Forearm, wrist and finger portion holding the wrist and fingers flexed. C, Tape which is wound between the finger portion of the splint and over the wrist to hold the splint in place. D, End view of the finger portion of splint, showing the attachment at X of tape C. A splint for extension of the fingers is made in a similar way.

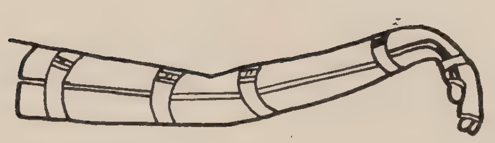

Fig. 401.—Plaster of Paris bandage holding the wrist and fingers flexed; a similar plaster is used when extension of the wrist and fingers is required.

The operator must decide on the value of the muscles and act accordingly.

The post-operative treatment is the same as that laid down under the transplantation of the palmaris longus.

286. Operation for Contracted or Short Extensors of the Wrist and Fingers. Lengthening the Muscles by a Subperiosteal Operation at the Condyle.—Contractures of the fingers and wrist, due to shortening of the long extensors of the wrist and the fingers should be overcome by carefully applied splints. When the deformity is extreme this is not always possible. When stretching and manipulation have been performed in a careful and accurate manner over a considerable period of time, additional length for the extensor tendon may be obtained by

loosening the attachment of these muscles at the elbow. This operation is very satisfactory when the tendons are evenly contracted.

OPERATION AT THE CONDYLE

The patient lies on his back, the arm is laid across the thorax. The operator stands on the same side of the operating table as the arm to be operated on. When the extensors are contracted, an incision two and one-half inches long is made over the outer condyle of the arm down to the bone. The muscles are detached subperiosteally from the external condyle by means of a small osteotome; the detached muscles are pushed downward until the fingers can be completely flexed.

Post-operative treatment

An apparatus should be worn after the operation continuously for eight weeks and for part of each day after that, depending on the tendency of the muscles to recontract.

FIG. 403. — Tendon shortening, portions to be removed are here shaded.

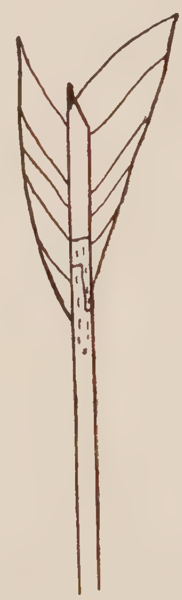

FIG. 404.—Suture of shortened tendons.

Operation on the belly of the muscle for lengthening the long extensors of the wrist and fingers

An incision is sometimes made over the contracted muscles and a few fibers cut at different points in the belly of the muscle to allow it to stretch down. The tendons may be cut and lengthened in the belly of the muscle (figures 396 to 398). Lengthening at the condyle or in the tendon over the muscles are the better procedures.

Post-operative treatment

Extreme overcorrection should be maintained at the time of operation. It is often necessary to manipulate the finger and wrist joint after a deformity of long standing. Each joint should be carefully manipulated. Contracted fibers will yield with very little reaction to gradual force frequently relaxed. The relaxing of force and repeated stretching should be done without roughness until the joint yields. Weak muscles cannot be expected to gain until their strong opponents and the tissues limiting motion are all overstretched. At times in addition to lengthening the extensors it is necessary to shorten the flexors as described elsewhere in these pages.

287. Operation for Contracted Flexors of the Wrist and Fingers. Tendon Lengthening.—The incision is made over the flexors and the tendons lengthened as described for lengthening the contracted tendons of the extensors (figures 396 to 398).

288. Operation for Contracted Flexors of the Wrist and Fingers, Lengthening the Muscles by a Subperiosteal Operation at the Condyle.—This operation is done at the internal condyle in a similar way to that described for contracted extensors of the forearm performed at the external condyle. See section 386.

After operation the elbow is held at right angles, the wrist and fingers are put up in a position of extreme extension. Otherwise the post-operative treatment is the same as that for contracted extensors.

It is sometimes necessary to shorten the extensors as well as to lengthen the flexors. The operator should see that the finger, wrist and elbow joints will bend normally to allow use after correcting the condition.

289. Operation for Shortening the Long Flexors of the Wrist and Fingers. Muscle and Tendon Shortening.—The patient lies on his back, the arm rests on a table. In operation on the right arm, the operator stands facing the external condyle of the humerus. The assistant stands between the body and the arm. For the left forearm, the positions are reversed.

OPERATION

A longitudinal incision three inches long is made over the middle of the forearm at the junction of the middle and lower third. It should extend through the skin and fat which are dissected up in one layer.

When the tendons are reached, any one of the methods described under tendon shortening may be used. Each tendon should be noted previous to operation and the required amount of shortening or lengthening estimated for each tendon. At the time of operation, the surgeon pulls on the tendon and recognizes it from its action on the wrist or finger. Each one is shortened as planned before operation. The shortening is done either in the tendon overlying the muscle or below the muscle (figures 403, 404). When the operation is completed a small piece of gauze four or five layers thick is placed over the wound, extending a half inch beyond at either end and one inch broad. Sterile sheet wadding is placed over this and the arm and hand are held flexed by a wire or aluminum splint holding the wrist flexed, or a plaster of Paris dressing. The front half of the plaster may be removed. A gauze bandage is then applied after removing the front half of the plaster. This operation is recommended when the opposing muscles have stretched out the flexors. To assure a permanent result the strong extensors should be stretched out daily. In extreme cases, the extensors should be lengthened at the time of operation (figures 396 to 398).

After treatment

A splint is worn constantly for two months after the operation. After that the splint is removed more and more; finally being used only two hours daily for one or two years, depending on the tendency of the deformity to recur. Exercises and muscle training should be light at first and continued at least as long as the splint is thought necessary. In most cases the arm should be exercised for several years after the splint is discarded.

290. Operation for Shortening the Long Extensor Tendons of the Wrist and Fingers. Muscle and Tendon Shortening.—The patient lies on his back, an assistant holds the flexed elbow on a table, the operator sits facing the posterior surface of the forearm and makes an incision three inches long in the lower half through the skin and fat exposing the tendons. The tendons may be shortened in the muscle or below it (see Tendon Shortening).

The detail of the operation of tendon shortening is now similar to that described for shortening the long flexors of the fingers. (Section 289.) Each tendon should be noted previous to operation and the required amount of shortening or lengthening estimated for each tendon. At the time of operation the surgeon pulls on the tendon and recognizes it from its action on the wrist and finger. Each one is shortened as planned before operation.

Post-operative treatment

After the operation a plaster or wire or an aluminum splint is applied, holding the elbow at right angles and the wrist and fingers fully extended. In extreme cases it may be necessary to lengthen the flexors. The success of the operation depends on the same treatment and after care laid down for the post-operative care in shortening the flexor tendons of the forearm.

291. Operation for Paralysis of the Extensor Longus Pollicis or Extensor Longus Digitorum. Transplantation of the Palmaris Longus. —Where the extensors of the fingers are paralyzed the palmaris longus is exposed by an anterior incision, its tendon freed below; the muscle dissected up to the middle of the forearm where a blunt dissector is used to separate the muscles, and the interosseous membrane. As the blunt dissector is made to protrude posteriorly, an incision is made through the skin over it, a tendon carrier or long clamp is passed forward from the posterior to the anterior incision and the tendon grasped and drawn out posteriorly. A towel is placed above and another below the tendon, while silk is quilted up one side and down the other. The posterior incision is extended downward and the paralyzed tendons exposed, the surgeon pulling on each one to assure himself to which joints they go. The tendon of the palmaris is attached by its silk, quilted into the extensor tendons on the back of the forearm, with or

without passing it through a slit in the paralyzed extensors; these are all quilted with the silk from the palmaris tendon. (See figures 408, 409). The muscle transplanted should hold the fingers slightly extended. The method of applying the silk is described under transplantation of the peroneii. Section 148.

After treatment

After operation, a wire or aluminum splint or plaster is worn stretching out the strong muscles and relaxing the transplanted and weak muscles. The splint should immobilize the elbow, wrist and fingers for three weeks. After that finger motions are encouraged each day. The splint is worn for six weeks and omitted a little at a time. After that muscle training and exercise are started before the eighth week.

The splint is gradually omitted except for two to four hours a day, depending on the tendency of the strong muscles to recontract. The rules for lengthening tendons and muscles are given elsewhere in these pages, should it be necessary to readjust other tendons in addition to transplanting.

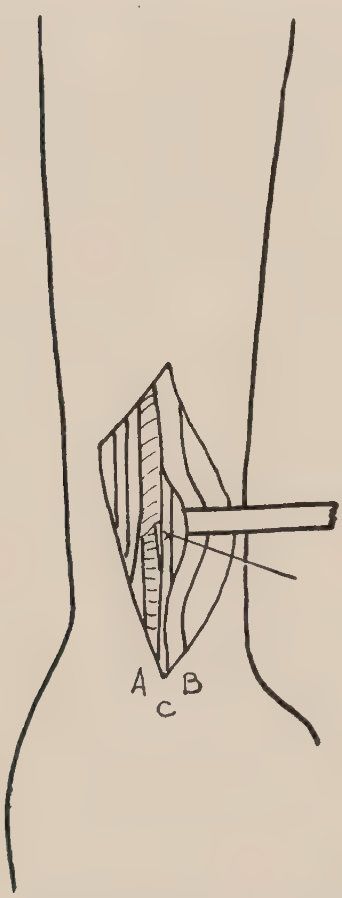

Fig. 405. — **Incision for** paralysis of the flexor longus pollicis when the flexor carpi radialis is spared. A, Median nerve. B, Flexor carpi radialis. C, Flexor longus pollicis.

292. Other Transplantations in the Forearm, for Paralysis of the Extensor Longus Digitorum or the Extensor Longus Pollicis.—At the wrist, the flexor carpi ulnaris and the flexor carpi radialis, the palmaris longus and in some cases the extensor carpi radialis, when spared, may be transplanted to take the place of the extensors of the fingers or thumb in a manner already described for the transplantation of the palmaris longus.

293. Transplantations in the Forearm for Paralysis of the Flexor Longus Digitorum and Flexor Longus Pollicis.—In paralysis of the flexor longus digitorum and flexor longus pollicis, the extensor carpi ulnaris, or the extensor carpi radialis and the flexor carpi ulnaris one or two may be brought forward and inserted into the flexors of the fingers or thumb as described for the transplantation of the palmaris longus backward.

294. Operation for Paralysis of the Flexor Longus Pollicis when the Flexor Carpi Radialis is Spared.—The flexor carpi radialis may be used (see figures 405 to 407) for paralysis of the flexor longus pollicis and transplanted as described for transplantation of the palmaris longus.

295. Operation for Paralysis of the Flexors of the Wrist, Transplantation of the Extensor Carpi Radialis and the Flexor Carpi Ulnaris.—The extensor carpi ulnaris or extensor carpi radialis may be transplanted forward as described for the palmaris longus when transplanted backward.

296. Nerve Supply in the Forearm.—As an additional guide in paralytic cases the following summary of the nerve supply may be of

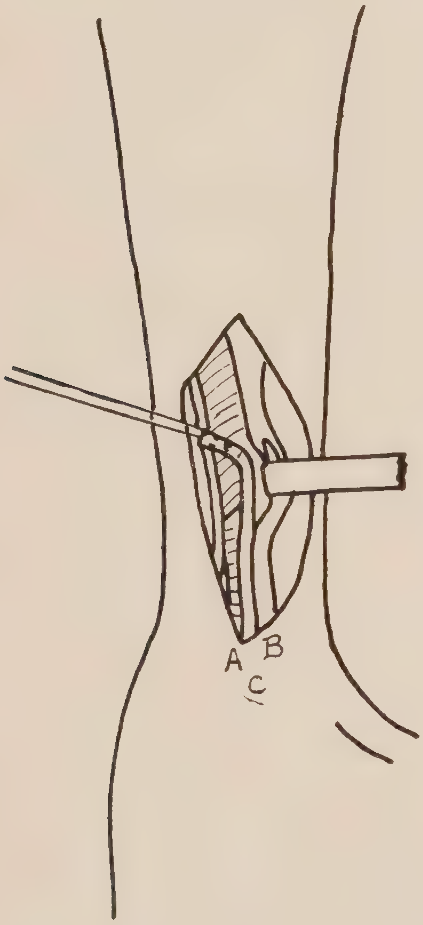

Fig. 406.—B, The flexor carpi radialis is split and retracted. C, The flexor longus pollicis is cut away and its distal end quilted with silk.

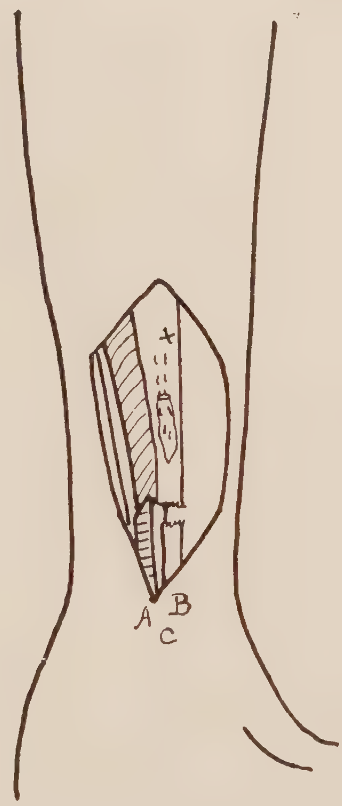

Fig. 407.—The flexor longus pollicis (C) is passed through the flexor carpi radialis. Quilted sutures unite the tendons. The flexor carpi radialis is cut across to allow free action of the thumb.

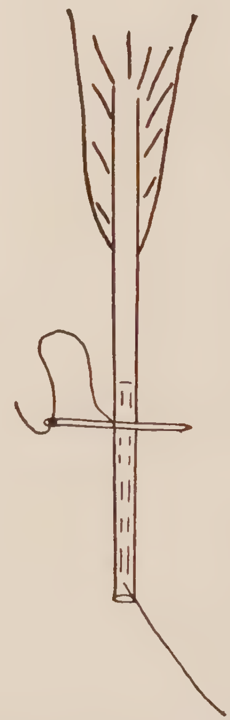

Fig. 408.—Silk tendon elongation to replace a cut or adherent tendon. The needle should pierce the tendon at right angles in applying the silk.

help. The operator should get a strong voluntary reaction in any muscle he intends to transplant. Without good control the muscle will be of little value. Sometimes it is necessary to train the muscles to the proper strength. At the time of operation the muscle to be transplanted, to be satisfactory, should be a good red color even when a tourniquet is applied.

The pronator and flexor muscles of the forearm receive their nerves mostly from the median, only one, the flexor carpi ulnaris, being wholly and another, the flexor profundus digitorum, in part supplied from the ulnar nerve by branches entering them near the elbow. The pronator radii teres, flexor carpi radialis, palmaris longus, and the condylo-ulnar

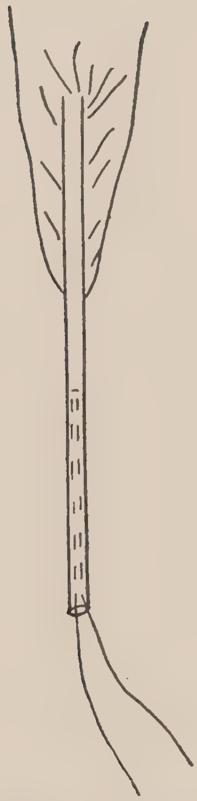

Fig. 409.—Silk applied to the tendon.

head of the flexor sublimis digitorum receive branches from the median in the neighborhood of the elbow, while the radial head and the index finger belly of the flexor sublimis have separate twigs from the same trunk. The flexor longus pollicis, pronator quadratus and outer half of the flexor profundis digitorum are supplied by the anterior interosseous branch of the median. The outer two lumbricales are innervated by the median and the inner two by the ulnar (Quain's anatomy).

The anconeus, supinator longus and extensor carpi radialis longior receive branches from the musculo-spiral nerve, the remaining muscles of this group are supplied by the posterior interosseous division of that trunk, the offsets for the extensor carpi radialis brevior and supinator brevis arising from the nerve before it pierces the matter muscle, while those, for the extensors of the digits, both superficial and deep as well as the extensor carpi ulnaris are given off after it appears on the back of the forearm (Quain's anatomy).

CHAPTER III

INCISION PUNCTURE AND ARTHROTOMY

297. Arthrotomy at the Wrist.—A knowledge of the important routes of approach to the joints will facilitate any joint exploration, the removal of foreign bodies, the repair of traumatic conditions, the adjustment of difficult fractures, the reduction of old and difficult dislocations, the mobilization of joints where motion is partially or totally lost, and the stiffening of the joint as in certain paralytic conditions, the treatment and drainage of suppurative conditions; a knowledge of the important routes of approach to the joint is very important. For each case, the operator will select the incision best suited for the individual condition. Each joint will be considered separately in other chapters.

The incision should be made down to the synovial cavity. All bleeding should be stopped and the synovial membrane carefully opened. The joint structures should be tampered with as little as possible, the synovial membrane brought together carefully and the layers over it closed in order not to disturb the function of the periarticular tissues. Unnecessary separation of the tissue layers is to be avoided. Tendons should be left in their sheath. Any ligaments that must be cut should be loosened periosteally, in order that they may be readily replaced. Early motion should be the rule, gentle at first, and gradually increased.

Arthrotomy at the wrist is done for deformity, congenital or acquired, compound fractures, ankylosis following injury or disease and suppurative conditions. Joint operations should never be hastily considered and should be avoided by anyone not familiar with the best surgical technique.

When it is necessary to have free access to the bones on account of fracture, deformity or suppurative disease, less injury is done to the soft parts if the operator will use an anterior and a posterior incision at the same time rather than a single incision. It must be remembered that any operation at the wrist may involve serious injury or adhesion or even sloughing of the tendons which later may interfere seriously with the action of the fingers. This can be avoided by sufficiently long incisions to allow easy retraction of the tendons undisturbed in their sheath with the underlying periosteum still attached. The posterior annular ligament must be incised. With one finger through the anterior and another through the posterior incision it is possible to manipulate or remove the bones without roughness and trauma. The amount of swelling, pain and injury from the operation will be correspondingly less.

For exploratory operation on the wrist, the anterior or the posterior

incision may be used, or both. The posterior is preferable where only one is to be used. It extends from between the styloids to the second or third metacarpal.

For purposes of drainage, an anterior and posterior incision should be made and sometimes a radial or lateral, depending on the extent of the disease or injury. An x-ray will help determine.

For simple irreducible fractures, compound fractures, dislocation or internal displacement demanding operative intervention, the anterior and posterior incisions should be used unless one is sufficient, but for suppuration at the wrist two or more incisions are necessary.

When removal of one or more bones is necessary as in tuberculosis, a better result as to function is obtained when all the bones are removed with perhaps the exception of the pisiform and perhaps the trapezius, the unciform process of the unciform may be left. Even when only one bone is diseased there is less danger of stiffness by a complete excision. There is never abnormal mobility if the operation is done subperiosteally even though all the carpal bones are removed.

298. Arthrotomy at the Wrist. Ollier's Incisions.—Ollier advises three incisions for suppurative conditions, an anterior lateral, a posterior and a small external for drainage when necessary.

The arm is evasculated by an esmark and tourniquet (the tourniquet is applied over a towel for a short time only). The skin having been carefully prepared and the field of operation protected, the arm rests on a small table to one side of the operating table. The operator sits facing the side of the table, his assistant faces him. The arm is pronated and rests on a sand bag.

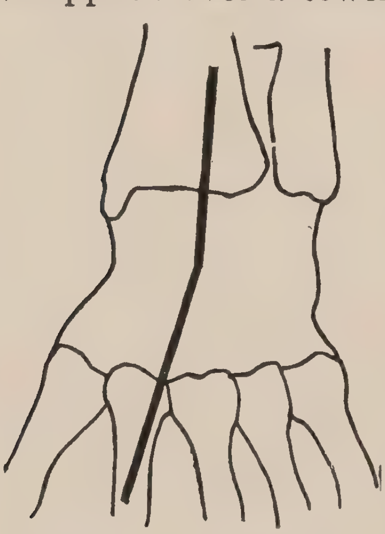

FIG. 410.—Posterior incision. Starting one inch above the styloids and passing through the middle of a line connecting them along the outer border of the extensor indicis to the middle of the second metacarpal.

299. Posterior Incision.—An incision is made midway between the styloids starting one inch above them and extending vertically downward through the posterior annular ligament to the middle of the second metatarsal along the outer side of the extensor indicis. The dissection is carried down to the periosteum, the extensor indicis is to be retracted inward and the extensor secondi internodii outward. The extensor carpi radialis longus and brevis should be spared and detached subperiosteally (see figure 410).

300. Arthrotomy of the Wrist. Anterior Incision.—A palmar incision is made over the radial border of the ulna starting one inch above the styloid process and extending to the base of the fifth metacarpal, leaving the flexor carpi ulnaris to the inner side. This incision is carried down to the periosteum (figure 411).

301. Radial Incision.—A third incision is now made when necessary (see figure 411), one inch long over the styloid process of the radius; it is carried down to the bone and made before removing the carpus. For complete drainage, for tuberculous or purulent disease, three incisions are made. The operation is continued as the case requires.

For adjustment of fractures, correction of deformity or excision, where there is no active disease the posterior and anterior are all that are necessary.

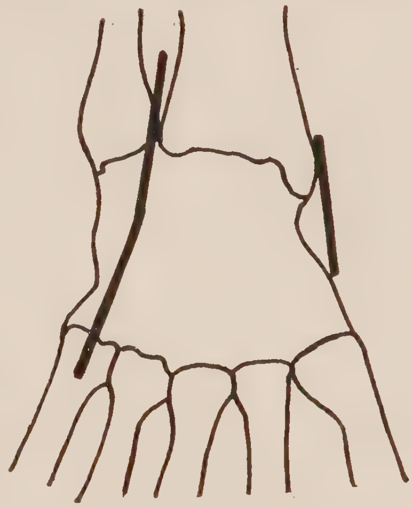

Fig. 411.—Anterior incision. Starting one inch above the styloid along the radial border of the ulna to the base of the fifth metacarpal, the flexor carpi ulnaris to the inner side. The radial or external lateral incision is made over the styloid of the radius for one or one and one-half inches.

302. Arthrotomy at the Metacarpal and Phalangeal Joints. Operations on the Long Bones of the Finger and Hand.—The finger joints are best reached by one or two dorsal incisions between the tendon and the artery. When necessary a palmar incision similarly situated is made, but in view of the tendency to scar contracture it is better to have the incision on the dorsum. (See figures 412, 413.)

The incision is made with a scalpel down to the bone through the periosteum. A long handled small osteotome is then used to raise the periosteum exposing the joint and the bone, above and below, without disturbing the structures between the periosteum and the skin. Hooks or small retractors are used, exposing the bone or joint. When the joint is subluxated, the ligaments may be relieved subperiosteally and the joint replaced. In some instances it is necessary to excise a portion of the bone as described for hammer toe. The long bones of the hand and finger are reached in the same way.

Fig. 412.—Incision for arthrotomy at the metacarpo-phalangeal joint.

303. Arthrotomy for Fractures about the Joints.—The necessity of immediate operation in fractures about the joints depends, as in other fractures, on the acuteness of the local and general reaction. When these do not contra indicate immediate operation, certain fractures about the joints may require treatment by the open method. Among these are all compound fractures, even when the protrusion of the bone has been extremely slight, all fractures that cannot be reduced by manipulation or in which the correction cannot be maintained or where apposition is impossible, many fractures combined with dislocation, articular fractures with pieces locking or limiting the joint action.

Where there is a great deal of trauma, and in multiple fractures, and in cases where there is a great deal of shock, all that can be done is to

immobilize the parts until a favorable time for operation. In selecting a suitable time for operation when it is found necessary to operate on a fracture if there is no immediate contra indication, the sooner it is done the better. Where there is tremendous swelling the surgeon should always wait. All cases should be operated on that show no union after three months of good treatment.

Fig. 413. — Incision for arthrotomy, phalangeal joint.

Methods of treating the individual fracture cannot be considered in a limited space like this. The writer has described the routes of approach to the different joints and the technique of these. This will enable the surgeon from his knowledge of fractures to select the route best adapted for the individual treatment required and when necessary two or more incisions may be used. A knowledge of the technique will enable the surgeon to work rapidly in reaching the fracture on which he expects to spend time.

304. Fractures of Long Standing Still Ununited or United with Deformity, Preventing Function. Fractures near or of the Carpus.— Deformity from fractures at the wrist may be corrected by an osteotomy of one or both bones as the case requires. An incision is made as for excision of the wrist or at the side separately for each bone. The bones are cut through by means of an osteotome, and the case treated as if it were a fresh fracture by well fitting anterior and posterior splints. When there is deformity low down and the fracture is under three weeks old, it is usually possible to manipulate the fracture, and correct the deformity without an open incision. The treatment of fracture of both bones by the open method is described elsewhere in these pages. The Thomas wrench as described in these pages, may be used to manipulate the wrist. This has been suggested by Dr. Stone.* Separation of the epiphysis with deformity may be corrected by means of a Thomas wrench, if the fracture is three weeks old. Occasionally it is possible to correct fractures, when they are five weeks old, when the union is soft. The surgeon should be careful to avoid trauma in manipulating the fracture. It is better to cut the bone with an osteotome and avoid trauma, than to manipulate to such an extent, with force, as to cause a great deal of swelling.

In injury of the carpus, the bone most commonly fractured is the scaphoid. The semiluna may be displaced with or without fractures of the scaphoid. In fractures of the scaphoid, the fracture heals without giving any trouble.

Occasionally there is displacement of one of these bones or of a fragment. Where there is displacement, sometimes it is impossible to manipulate the fragment into position. When this is the case, an incision is made and the displaced fragment removed. Occasionally the whole bone should be removed. An excellent result

* Dr. J. S. Stone, Boston.

follows the operation. Fracture of the scaphoid will limit motion in extension of the wrist without limiting flexion to any great extent. Displacement of the semilunar bone may require removal of this bone to obtain good function of the wrist, when after long immobilization function is still impaired.

In any case where there has been infection, no plastic operation should be used until the infection has been entirely absent for at least nine months. A year is safer. Where the infection is very mild and of long standing, during the process of treatment the patient may be allowed to use the arm if the local reaction is not too great. It is of advantage in certain cases to use a wire or leather splint to take some of the strain. Where the x-ray shows conical ends of the bone it is practically useless to expect union without surgical interference.

305. Tapping the Wrist Joint.—The most scrupulous aseptic precautions are necessary both as to the preparation and the protection of the field of the operation.

The forearm is pronated and the joint tapped at the styloid process of the ulna between it and the long extensor tendons, or at the level of the styloid of the radius between the extensor longus indicis and extensor longus pollicis. The tapping may be done under local anæsthesia.

When there is much effusion it is not difficult to reach the joint. If fluid is to be drawn, and other solutions are to replace it, the amounts should be carefully measured. Two good graduated metal syringes are very useful. All of their parts should be tested beforehand. The trocar is made to enter the joint and then is connected with the syringe. As little air as possible should enter the joint. The trocar should be of large diameter as the fluid may be thick or flaky. When the patient is not anæsthetized for the operation it is often well to have a short flexible tube connect the trocar with the syringe. This should be fastened at both ends by silk ties so that it will not leak easily when pressure or suction is used. If the joint is to be washed out a definite amount of fluid is injected and the return measured in a sterilized measuring glass.

Dr. Murphy uses a formalin glycerine solution as follows: liquor formaldehyde 2% in glycerine, about ten drops of the formaldehyde to each ounce of glycerine.

This acts very well in infectious synovitis. But it should not be used in arthritis deformans nor in old chronic arthritis.

The tapping may be done with ethyl chlorid or novocaine adreneline solution, 1%. The solution should be prepared twenty-four hours before it is used (Murphy).

CHAPTER IV

OPERATIVE TREATMENT IN CASES OF JOINT ANKYLOSIS

306. Arthroplasty.—Ankylosis may be bony, cartilaginous or fibrinous, it may be periarticular, ligamentous and capsular, or extra articular, that is, skin scars, tendons, fascia, nerves and arteries.

The form of ankylosis that exists will determine the treatment. A partial ankylosis at certain points had better not be treated by an arthroplasty.

Age must be considered, also the general condition of the patient. When the ankylosis is bony, cartilaginous or fibrinous, arthroplasty is indicated. When the condition is periarticular or extra articular, it may be treated by capsulotomy, tendon elongation, excision of exostosies, etc.

Dr. Murphy lays stress on the following points:—The principles of asepsis to the finest detail are absolutely essential. One not familiar with the best surgical technique should avoid arthroplastic operations. The exposure of the joint must be generous and complete. The contracted capsular ligaments and soft parts must be freed and if necessary lengthened. The normal contour of the joint should be restored as nearly as possible. The operator should obtain a hyper-mobilization of the joint. The joint should be reshaped to give stability. The interposition of material to prevent reunion of the bone is necessary.

The principle is to separate the bones and to interpose between them material to prevent ankylosis. The best material for this purpose is the human pedicle composed of fat, muscle, fascia or a combination of these.

When this is not possible, a transplantation is made of fat and fascia from the trochanter bursa region or from the fascia lata.

Materials such as ivory, celluloid, silver are not good. Materials that will not absorb or that absorb too slowly are not desirable.

During the operation the soft parts should be freely liberated. Attach the interposing flap to one bone only and cover it completely. Early motion, that is, at the end of five to seven days is necessary with or without gas or gas and oxygen.

Dr. Murphy records failures in arthroplasty as due to first, insufficient and defective exsection of the capsule and ligaments, second, insufficient interposition of fat and fascia between the separated bony surfaces, third, infection, fourth, the sensitiveness to pain on motion after operation.

Cases of primary tuberculosis and cases of recent infection that have subsided are not suitable cases for arthroplasty. In operation, in addition to the usual protection of the field of operation, after the skin and

fat have been incised, towels should be clamped to the edges of the skin as an extra protection.

307. Arthroplasty in Ankylosis of the Wrist.—In ankylosis of the wrist very good motion and function are possible by a complete incision of all the carpal bones as described (see Excision of the Wrist).

The function is usually so good that an arthroplasty is uncalled for at this joint.

A stiff wrist should not be interfered with in cases of chronic rheumatism where the fingers and other joints in the arm are affected by rheumatism unless it is badly deformed or unless the patient is very healthy and the rheumatism has entirely subsided. Where the disease is of an infectious or tubercular nature and in the wrist only and where the patient is in good health, an excision at the wrist may be done to relieve the ankylosis.

308. Arthroplasty for Ankylosis of the Finger.—A dorsal incision is made just to the side of the tendon between it and the artery; usually two dorsal incisions are necessary. They are carried carefully down through the periosteum, a long handled small osteotome is used to raise the periosteum completely from the two bones without disturbing the tissues between the periosteum and the skin. The lateral ligaments of the joint are removed in a similar way. The necessary bone is removed to allow easy motion of the joint. The bones are shaped as nearly as possible to conform to the natural shape of the joint. A flap of fascia is cut from the thigh and placed over the end of the bones and sutured to one bone overlapping its end. The finger fibrous tissue may be used for the same purpose. There is less disturbance of the mechanism of the fingers by diminishing the dissection and using fascia lata.

The incisions are closed with chromic catgut number 00. Enough bone should be removed to allow easy motion. There should be very little disturbance of the other tissues.

The finger, hand and wrist are immobilized on a palmar splint extending to the elbow. Gentle passive motion is allowed after seven to ten days, depending on the amount of pain and swelling.

CHAPTER V

OPERATION IN SUPPURATIVE CONDITIONS

309. Suppurative Condition at the Wrist.—When the condition at the wrist is one of severe acute suppuration, the anterior and posterior with the radial incision should be used, the disease well drained, the abscess cavity washed with salt solution and wiped out with gauze strips. When necessary the bone is incised and cleaned out with a chisel or osteotome. After operation the incisions are kept wide at the corners with gauze and tubes placed between them.

A stiff wrist often results from suppurative conditions. Motion is always obtainable by operative measures unless the tendons are extensively involved in the adhesions. A constantly painful and weak wrist is disabling when due to chronic suppuration. Drainage followed by an excision or an excision from the first is justifiable and gives a very excellent result when carefully done. Any very acute suppurative condition should be allowed to subside after drainage and an excision then done will give promise of excellent wrist motion. If the condition is sub-acute the disease may be removed and an excision done at the same time. The joint should be immobilized and the fingers allowed to have free motion. See Carrell-Dakin Technique, section 323.

310. Osteomyelitis at the Wrist.—In osteomyelitis an operation should be done as early as possible after making the diagnosis. In sub-acute cases, incision and drainage are all that is necessary. Whenever incising for abscess all the pockets should be opened and if the abscess is large, counter incisions are made at dependent portions. The pus pocket should be opened freely, wiped out with gauze, irrigated and wiped out again with gauze. Curetting should be avoided excepting for the removal of sinuses in the skin, and in cases of sinuses it is often better to excise them. Perforated rubber tubing should be placed to drain the deepest portion of each pocket. The skin, fat and superficial muscle layers should be made to gap by means of gauze drains. At the end of ten days the gauze is removed and the tubes shortened. The tubes are gradually drawn out a little each day or two until not used. This method makes the repeated reapplication of drains and wicks unnecessary as the wound will gap of itself and close from the bottom if the surgeon has been careful to make large incisions.

Where this is necessary, the incisions should be large and a counter incision should be made on the other side of the bone with a hole made in the bone. Splints should always be applied to immobilize the limb. They should be placed so that they will not interfere with the dressing. In some instances it is better to apply a plaster with

large windows and ropes to give stability. The dressings should be done every day or twice a day, depending on the foul condition of the discharge. If the odor is excessive chlorinated soda dressing should be used diluted, using it $^1/_2$, $^1/_3$, $^1/_4$ the U. S. P. strength. The gauze drains should remain for at least ten days without being disturbed. When removed granulations will be formed under them in such a way as to keep the wound open without applying drains. Irrigation may be used at the time of the operation and the wound thoroughly wiped out with gauze afterwards. No irrigation or probing or application of wicks will be necessary if the first drains are left in long enough. After the first ten days the tubes are shortened gradually until they are not needed. See section 323.

In severe cases where the patient is unconscious or delirious the bone should always be opened. No tight packing should be used, as this interferes with good drainage. Where sequestra have formed they should be removed. An x-ray should be taken whenever possible to determine the position of the disease (unless the case is urgent and an immediate x-ray is not obtainable).

In cases of long standing that are sub-acute at the time of first examination, where the bone is riddled with holes over an extremely long area, it is impossible often to remove the dead bone satisfactorily without removing all the bone. In these cases free incision down to the bone with frequent openings into the bone as described above, will allow the septic process to run its course and the sequestra to gradually separate.

Where sequestra are present it is always desirable to remove them as soon as they have separated, provided the involucrum is strong enough to act as a support. Sequestra may be superficial or in the medullary cavity or both. Where there is a persistent sinus and a sequestrum is present, pus will continue to form until the sequestrum is removed. Cases discharging several years where a sequestrum is present may close in a few weeks after removal of the sequestrum. See Carrell-Dakin Technique, section 323.

311. Excision of the Wrist.—When removal of one or more bones is necessary as in tuberculosis, a better result as to function is obtained when all the bones are removed with perhaps the exception of the pisiform and perhaps the trapezius; the unciform process of the unciform may be left. Even when only one bone is diseased there is less danger of stiffness by a complete excision. There is never abnormal mobility if the operation is done subperiosteally even though all the carpal bones are removed. An excision of the wrist will give a useful wrist with one or two-thirds or more of the normal flexion and extension. When the operation is done for a stiff wrist due to deformity, old fracture or inflammation that has subsided, very excellent results as to function are possible if the operator is careful to minimize the trauma in gentle handling of tissues, to use long incisions so that retraction is possible without separation of the delicate structures. Any adhesions that limit motion of the

tendons should be noted before operation and the fingers manipulated but not roughly to relieve this. If excision is decided upon no rough handling or breaking up of adhesions should be done at the time of operation. The removal of the carpus will relieve many of the adhesions and make extensive manipulation unnecessary. After the operation the action of all the joints of the fingers must be noted and the fingers manipulated so that their action will be unrestricted.

When the operation is done for suppurative conditions, conservative treatment should be tried first unless the disease is acute or of long standing, or extremely painful and conservative treatment has proved ineffective.

OPERATION

(Excision of the wrist) Ollier's incision

Ollier advises three incisions for suppurative conditions, an anterior lateral, a posterior and a small external for drainage when necessary.

The arm is evasculated by an esmark and tourniquet (the tourniquet is applied over a towel for a short time only). The skin having been carefully prepared and the field of operation protected, the arm rests on a small table to one side of the operating table. The operator sits facing the side of the table, his assistant faces him. The arm is pronated and rests on a sand bag.

Posterior incision

An incision is made midway between the styloids starting one inch above them and extending vertically downward through the posterior annular ligament to the middle of the second metatarsal along the outer side of the extensor indicis. The dissection is carried down to the periosteum, the extensor indicis is to be retracted inward and the extensor secondi internodii outward. The extensor carpi radialis longus and brevis should be spared and detached subperiosteally (see figure 410).

Anterior incision

A palmar incision is made over the radial border of the ulna starting one inch above the styloid process and extending to the base of the fifth metatarsal, leaving the flexor carpi ulnaris to the inner side. This incision is carried down to the periosteum (figure 411).

(Excision of the wrist) radial incision

A third incision is now made when necessary (see figure 411), one inch long over the styloid process of the radius; it is carried down to the bone and made before removing the carpus. For complete drainage for tuberculous or purulent disease, three incisions are made. The operation is continued as the case requires.

For adjustment of fractures, correction of deformity or excision, where

there is no active disease the posterior and anterior are all that are necessary.

The operator carries each incision described above in turn through the periosteum to the bone. Lifting the periosteum with a small long handled osteotome. It is to be retracted, leaving the surface of the bones uncovered of periosteum and the tendons and their sheath untouched. Wide separation of the overlying tissues en masse with the periosteum is necessary. The surgeon is now ready for the third step, the removal of one bone after another.

After removal or adjustment of the bones, the surgeon has the tourniquet removed. The deep tissues and periosteum are brought together with interrupted chromic catgut sutures number 00, the subcutaneous fat with interrupted chromic catgut sutures number 00, the skin with continuous chromic catgut sutures or horsehair. When suppurative disease is present the bones are removed, preferably with a small long handled osteotome. This instrument is used to separate the bones from the periosteum. The interosseous periosteum is removed with the bones leaving one large cleaned out cavity. This is wiped out with sponges and washed with salt solution when there is much suppuration. The ends of the metacarpal, the ulna and radius are inspected and any disease here removed. The styloids should be left in all cases even when other bone must be removed.

Excision of the wrist

In case of children where there is good bone and then suppuration beyond it in the epiphysis, the diseased bone is wiped with a sponge and an extra incision made directly over it to give immediate drainage, but the epiphysis should be left unharmed, the surgeon depending on good drainage to the epiphysis. The diseased bone is not removed at this point. The tendons, sheaths and ligaments should be untouched with their contiguous periosteum. If, however, the disease has penetrated to these tissues, it should be dissected away carefully. After completely clearing out the whole cavity it is washed out with salt solution and sponged out with gauze strips. After inspection, if the whole cavity is satisfactorily cleaned out, the tourniquet is removed. Large wads of gauze are made to gap the wounds at their corners and drainage tubes placed between. The third incision is used for drainage in suppurative cases only as described above.

After treatment

The tubes and gauze remain for eight to ten days and can then be safely removed and no other drains inserted. After operation a wire splint or plaster is applied holding the hand, forearm and upper arm firmly; the elbow at right angles. It should be applied so that inspection and all soiled dressing can be changed without disturbing the splint.

The windows in the plaster or open places in the splint should leave a margin of healthy skin beyond the incision at either end so that the splint can be kept clean. The splint should allow free motion of the fingers at the metatarsal phalangeal joints and beyond. Active motion of the fingers is encouraged on the fourth day and gentle passive motion if the active motion is not satisfactory. The splint is removed a little each day after the eighth week unless the suppuration is severe. In non-suppurative cases the splint is removed about the fifth week a little at a time until the muscles are strong enough to support the wrist.

312. Operation for Bone Disease in the Metacarpal or Phalangeal Bones or their Joints.—An incision is made on the dorsum of the finger between the tendon line and the artery (figures 423 and 424). The incision is made with the scalpel carefully down through the periosteum. A small long handled osteotome is used to raise the periosteum from the bone. This is retracted without disturbing the structures between the periosteum and the skin. In children the epiphysis should be interfered with as little as possible, a quadrilateral door is taken out of the shaft of the bone not extending to the epiphysis in children even when it is diseased. The cavity is wiped out, a tube or rubber drain inserted, and gauze is used to gap the soft tissues. These drains are left ten days, the dressing done after the operation or the third or fourth day and as often as necessary without disturbing the drains. These are shortened after the tenth day and later omitted. By this method the sinus will remain open without reapplying drains.

The forearm, wrist and fingers are held on a splint for a week or ten days; after that the unaffected fingers should be allowed freedom and the patient encouraged to use them. In some cases there is a swelling at the base of the wrist on the palmar side; in these cases and when the dorsum of the hand is swollen, there is a palmar abscess which will have to be drained especially if the patient is acutely ill. If there is no great virulence, but the hand is swollen, the wrist and forearm may be opened as well as the finger. The operator must be guided by the presence of pus, the general and local reaction. In any acute process daily soaks in antiseptic solution will be indicated for the whole arm and hand, with or without poultices, the old flaxseed poultices are usually the best unless they irritate the skin.

The treatment of the metacarpal bone is the same as that laid out for the phalangeal bones. The axillary glands should be examined.

313. Methods and Principles of Drainage in Acute Non-tubercular Suppurative Joint Disease. Wrist and Hand—A small suppurative focus without virulence or active constitutional disturbance should be drained by a suitable incision wiped out with gauze, a tube placed to its deepest part and the soft tissues gaped with gauze.

When there is a great deal of constitutional disturbance drainage and counter drainage should always be the rule. If the bone is involved this should be opened. The pus cavities in the soft tissues should be

wiped out. No extensive bone operation should be done otherwise. The bone should be drained with tubes to the remote portions and the muscle, fat and skin gaped by gauze. These operations are done quickly and should not be prolonged, but efficient drainage and counter drainage should be established unhesitatingly. The joint is immobilized and the fingers left free after all operations for suppurative conditions of the bone or joint near the wrist when possible.

In any extensive non-tubercular suppurating bone disease about the wrist or hand anterior and posterior incisions should be made at the wrist and on the back of the hand and back of the fingers when necessary. If the patient is very ill the operation should be done very rapidly and good drainage established. See Carrell-Dakin Technique, section 323.

PART VII—MISCELLANEOUS OPERATIONS

CHAPTER I

MISCELLANEOUS OPERATIONS

314. Torticollis Operation. (Figures 414 to 418.)—The patient lies on his back with a sand bag or hard pillow under his shoulders so there is slight tension on the sternocleidomastoid muscles. The tense muscle should be carefully noted before the patient is anæsthetized so that there will be no doubt as to which side is to be operated on. Under anæsthesia it is often impossible to tell which muscles are contracted. The head

Fig. 414.—The two portions of the sternocleidomastoid are exposed. The skin incision should be very small and stretched inward and outward to reach both portions of the muscles. (See figures 218, 219.)

Fig. 415.—A few muscle fibers at a time are divided on a director.

and thorax and shoulder are properly covered to protect the field of operation. An incision may be made one and one-half inches above the clavicle and parallel to it just above the clavicle or just below the clavicle.

When operating on a boy the incision over the clavicle is very serviceable. In operating on a girl an incision that will be covered by a necklace or a neck band is often preferred. For this reason an incision higher up is sometimes chosen. The skin in this region is very elastic and can be drawn up and down laterally without difficulty. For this reason the incision need not be more than three-fourths of an inch long. If the incision is made over the clavicle it is started an inch from the

sternal end of the clavicle and extends three-fourths of an inch outward. The incision is retracted inward while the operator separates the fibers of the inner end of the sternocleidomastoid and its sheath. The incision is gradually drawn outward as the outer fibers of the sheath and muscle are cut. A director is used to lift a few fibers of the muscle at a time in order to avoid unnecessary bleeding. Very rarely there is a moderately large vessel in the sternomastoid which bleeds after the muscle drops back in the wound. The operator should be careful not to miss these vessels, remembering that when the muscle fibers are lifted on a director they are tense and bleeding will not occur until after the fibers are relaxed. As the posterior sheath of the muscle is reached, the operator

Fig. 416.—Both portions of the muscle and its sheath must be completely divided.

Fig. 417.—On the neck a small incision can be pulled to one side and then moved to the other, exposing small portions of the muscle at a time. In this figure the incision is moved outward, in the next figure inward.

should take care not to injure the carotid sheath. The jugular sheath is not readily distinguished from the layers of fascia. If the muscle is very vascular it may be tied off and the fibers cut afterwards. Should any extensive oozing occur, packing with gauze strips for five or ten minutes is usually all that is necessary. When the operation is complete the operator should see that no fibers of the sheath and the muscle are left. He should put his finger in the wound and trace the anterior edge of the clavicle, the upper edge, and the posterior edge, looking for uncut fibers from the interclavicular notch outward. The fibers most commonly overlooked are superficial ones immediately under the skin and fat. These are more often neglected while the attention is concentrated on the deeper portions of the muscle. The string-like fibers that are sometimes overlooked do not materially interfere with the correction of the deformity when the operation is otherwise well done; they do interfere more or less with the cosmetic effect afterward. Suture.—The subcutaneous fat is brought together with interrupted chromic catgut

sutures firmly enough so that there will be no tension on the overlying skin. The skin is brought together with a subcutaneous suture and painted with compound tincture of benzoin, not, however, if iodine was used. Four layers of gauze a little longer than the incision and an inch wide are placed over the incision and painted with compound tincture of benzoin. This practically seals the wound before it is healed. The dressing may be inspected at the end of the fifth day.

In cases of spasmodic torticollis, a portion of the sternocleidomastoid is often removed instead of cutting it across.

Tillaux and Lange prefer cutting the sternocleidomastoid close to the mastoid process. When an operation is done here the incision is made over the mastoid process, the muscle should be cut close to the bone. The after treatment is the same with this exception, that the correction

Fig. 418. — The incision is moved inward; in the figure preceding it is moved outward, exposing each part of the muscle.

Fig. 419.—Showing a method of overlapping a stretched out muscle.

of the head should not be undertaken until the fourth or fifth day of convalescence; moreover, the correction should be gradually increased every second day as there is often too much strain on the pneumogastric nerve if overcorrection is instituted at once.

The success of the operation in congenital torticollis depends first on thoroughness, making sure that no fibers of the muscle of the sheath are left uncut; second, maintaining an overcorrected position of the head after operation for nine or ten months. The first four to six weeks a plaster of Paris is used, later a well fitting brace maintaining overcorrection. This apparatus is not uncomfortable as soon as the patient gets used to wearing it. The plaster (figures 420, 422), should include the head and thorax; the ears and top of the head should always be left out. In order to maintain the position of the head, the chin, the occiput and forehead must be held. After operations on the right sternocleidomastoid, the chin should be turned to the right. The left ear should be depressed toward the left shoulder and the cervical spine should be left

in a straight position otherwise. After operations on the left muscle the position is reversed.

315. Operation for Tenosynovitis.—When a tenosynovitis has not responded to conservative treatment it is sometimes necessary to operate, especially when it is tubercular. Incision and drainage are not sufficient. The tendon sheath must be completely exposed by a generous incision, and carefully dissected away from the tendon throughout its entire length. The tendon may be covered with sterile vaseline and replaced and the skin closed so that the tendon will not adhere to it. Fat or fascia may be used to prevent adhesions. This is the only operative measure that gives complete satisfaction in extensive cases.

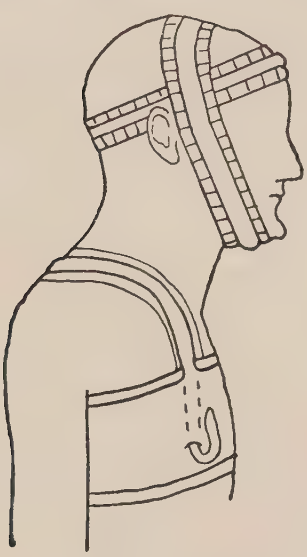

FIG. 420.—Torticollis plaster. The chest portion is applied over sheet wadding. The shoulder "plaster ropes" are applied over felt. The chin, head, occiput and forehead portions are applied over felt. The shoulder rope is turned back while it is soft. (See figures 421 and 422.)

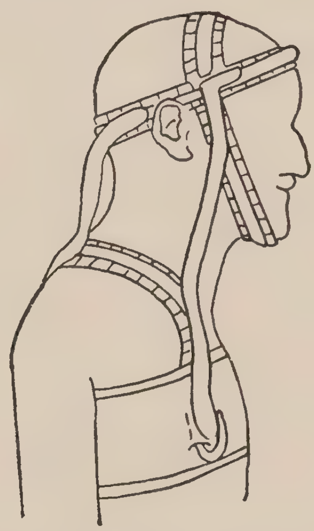

FIG. 421.—The body and head portions are connected by plaster ropes while they are wet. Plaster bandages are folded over them and incorporated into the plaster. (See figure 422.)

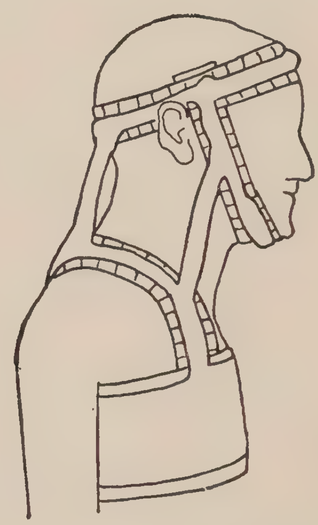

FIG. 422.—When the plaster is finished, the portion over the top of the head is cut away, allowing the head to be taken care of, the ears should be free, the plaster should be light.

Small local conditions may be excised, removing a small portion of the sheath above and below. The part should be immobilized for about a week and then motion of the tendon encouraged six or eight times a day, and the immobilization reapplied.

316. Bone Grafting.—In considering bone grafting, the operator should remember certain things which underlie the success of this operation. Absolute asepis to the smallest detail is essential. The bone to be grafted should be completely prepared before cutting the graft. The graft should fit snugly and be held in place by sutures or pegs. Whatever shape and type of graft and for whatever purposes used, the human graft either from the patient or another patient is better than a graft taken from an animal. The graft should have a good bony contact at each end with the medulla of the bone to which it is attached.

Both ends of the graft beyond the bridge should have as long a surface of contact as possible. Whenever possible this surface of contact should be at least two inches. When the tissues about the bone to be grafted are very debilitated or the soft parts very sclerosed from extensive scar formation or injury as in certain old ununited fractures, the fibrinous union between the ends is not removed except where the trough is made for the graft inlay. There will be much less disturbance of the tissue by this method and the repair in the extremely debilitated will be better than if the bones had been completely cleared on all sides.

When operating on healthy ununited fractures, large dissections may be done if necessary with impunity. With the debilitated and in the presence of extensive sclerosed tissues a minimum amount of trauma should be caused. (See Hibbs operation and Albee operation.)

In these cases the bone to be operated on is uncovered by a flap of fat and skin, the incision of which is some distance from the bone. When the flap is turned back the deeper tissues are incised directly over the bone in another line under the flap. Too much cannot be urged in favor of the large and long graft. Small, short grafts should be used as infrequently as possible. If there has been any inflammatory process with infection, no operation for bone grafting should be done until nine months or a year after the disappearance of all symptoms of inflammation. Method of suturing the graft in place is illustrated (see figure 423). The graft may be pegged with small bone pegs or by means of bone screws filling a tap drilled in the bone cortex.

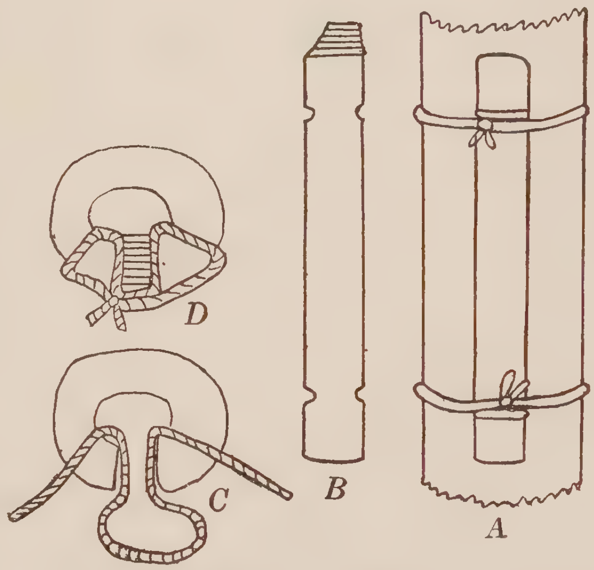

Fig. 423.—Diagram showing inlay bone graft. A, The graft in place held by catgut or kangaroo sutures. B, Bone graft showing grooves for the suture. C, A cross section of bone showing drill holes for suture and method of applying the sutures. D, Cross section of bone showing graft in shaded lines and the sutures holding it.

317. Operation for Rachitic Deformities.—In operating for bone deformities in rickets, an x-ray should be used to determine the advisability of operating; where the epiphysis show a fringy indefinite outline it is better to defer the operation. When the epiphyseal line is clear in the x-ray, the deformities may be corrected by osteotomy as described in these pages. Immobilization of the cut bone should be very perfect, the deformity overcorrected. After six weeks of bed and plaster of Paris bandages the patient is allowed to walk with the plaster on. When the rickets is still active, general hygiene, orange juice and anti-rachitic

diet should be prescribed. The apparatus to maintain correction of the deformity should be worn for about a year. Activity should be encouraged but with two to four hours of rest, daily, depending on the active condition of the rickets and depending on the strength of the child.

318. Arthroplasty of the Tempomaxillary Joint.—Ankylosis at the tempomaxillary joint as pointed out by Dr. Murphy may be articular or extra articular. An incision is made above the zygoma and parallel to it down to the fascia and not through it.

An incision is made from the posterior region of the ascending ramus displacing the parotid and facial nerves without injuring them. The vertical portion of the incision is one or two inches long from the lower margin of the zygoma straight up into the hair, passing in front of the ear. When the bone has been freed and a small portion removed a flap is taken from the temporal fascia and interposed between the divided surfaces. The coronoid may be found ankylosed to the skull in addition to ankylosis of the temporo-mandibular joint. This must be relieved by osteotomy and interposition of fascia to prevent bony union.

319. Infantile Paralysis.—Operations in infantile paralysis are fortunately not necessary in the majority of cases; very slight cases may be improved by muscle training and development exercises. The object of all treatment is to secure strength and stability at each joint about which paralyzed or partially paralyzed muscles play. To secure this, the joint must be made stable and firm and the muscles equalized or balanced. While it is true that the majority of poliomyelitis cases do not require operation, there are a selected few of the mild cases that are greatly benefited by it.

As there may be a partial paralysis in the individual muscle, or there may be a total paralysis of one or all of the muscles, the deformities and disabilities are correspondingly numerous giving an infinite variety of possibilities in the operative treatment. A selection of the operation must be based on a careful observation of the individual case.

Care should be taken early in the disease to develop the muscle and prevent deformity. In neglected cases or cases where the muscles have developed unevenly, deformity and contractures are often present; these must be corrected and the muscles brought to as high a state of efficiency as possible, then operations to improve stability of the joint, to improve motion of the joint, and to improve locomotion as a whole, are advisable.

In infantile paralysis, no operation should be considered early in the disease and no operation (excepting those to relieve deformities and contractures) should be done until the second or third year after the onset of the disease. Deformities should be corrected by operation or otherwise as early as possible in order to allow the tissues to recover, then the muscles and tissues should be brought to as high a state of function as possible.

When deformities and contractures have existed and are relieved by

operation there will be much gain in the strength and the development of the limb. Deformities and contractures that are extreme when relieved will often allow the muscles to gain a great deal, especially if the surgeon understands the training of muscles in paralytic conditions. Slight deformities left uncorrected often impede the recovery of partly paralyzed muscles.

The operations which are undertaken to increase the usefulness of the leg should never be done until deformities have been relieved and the muscles trained. The question as to which operation is most appropriate for the individual case is a matter largely of judgment. Operations will relieve disability, aid in locomotion and give better function and often make braces unnecessary. The operations are considered in the different chapters according to the joint affected by the paralysis.

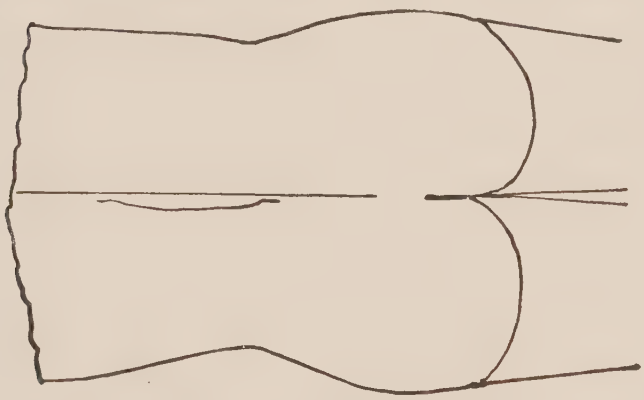

Fig. 424.—Skin and fat incision for plastic operation on the spine or for lamenectomy. The ends of the incision do not cross the median line.

320. Plastic Operation on the Spine for Potts Disease.—A plastic operation on the spine to fix the spine in Potts disease has been a valuable contribution to the treatment in many cases. There is very little choice between Dr. Hibb's and Dr. Albee's operation as to the ultimate result. In the hands of the less skilled, Dr. Albee's operation is a simpler one.

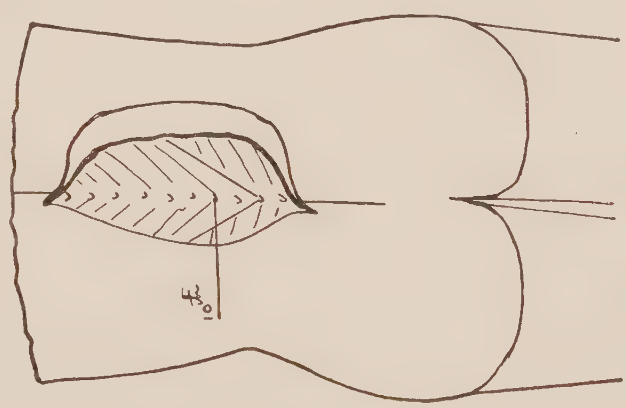

Fig. 425.—After retracting the skin and fat, the incision is made in the median line or slightly to the side through the ligament, the spines and the interspinous ligament. Albee operation.

When there are signs of paralysis in the leg, neither of these operations should be done until the spine has been hyperextended and undergone treatment to relieve the pressure on the spinal cord. When the necessary relief has been obtained and the muscular strength has been returned in the legs, the operator then may select the operation best suited to the individual case. In children that live near enough to report for observation, brace and jacket treatment are preferable to the operation. Where the deformity is increasing or the children are apt to be neglected or live so far off that they cannot report frequently enough for observation, then a plastic operation on the spine is often advisable. In adults an operation is preferable to jacket or brace treatment as it materially shortens the disability and the course of disease and enables the

patient to go to work in a comparatively short time. In children, apparatus treatment will not interfere with their going to school and being perfectly well. In adults the discouragement and debility following the lack of work is so discouraging that an early operation should be done especially if there is no paralysis. Where paralysis is beginning, recumbent treatment should be used until recovery has been made and then an operation performed.

321. Operation for Obtaining Ankylosis of the Spine. Albee Operation.—The patient is brought into the operating room on a Bradford frame, lying in a posterior plaster shell which has been made several days before and which holds the spine in the position which the operator wishes the spine to be after operation. This plaster should not only have been made several days before but should be tried on and found to be comfortable before using it at the time of operation. The patient is put on the operating table and when anæsthetized is turned on his abdomen. The surgeon marks lightly on the skin with a scalpel the upward and the lower limit of the spine to be immobilized.

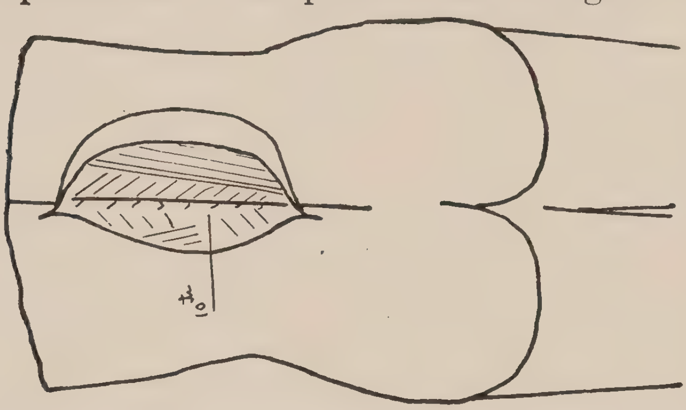

Fig. 426.—The spines and inter-spinous ligaments are split. Albee operation.

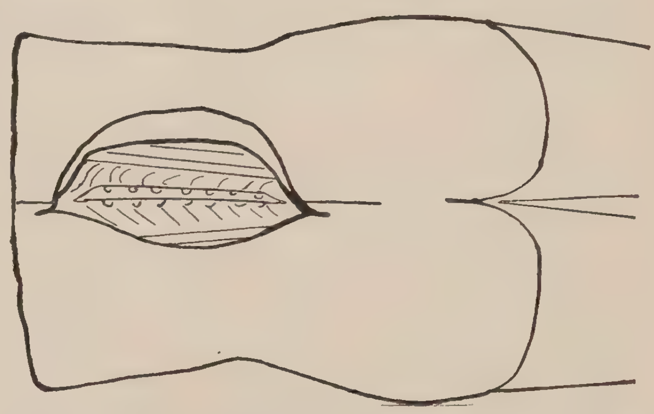

Fig. 427.—A probe is used to measure the shape and length of the desired graft. Albee operation.

An incision is made slightly above and extending slightly below these marks. The incision should be one-half inch to the side of the spinous processes and parallel to them. It is carried vertically through the skin and subcutaneous fat. This is retracted exposing the spinous process (see figure 424). These are incised through their middle with an osteotome so that they are split continuously with the spinous and inter-spinous ligaments (see figures 425 to 427). When the space between the bone and inter-spinous ligaments is completed and retracted, the operator uses a probe to measure the length of the graft necessary and bends the probe to the shape of the cavity. The back is covered with a sterile towel. The knee is flexed about 35 degrees beyond right angle and the ankle held by an assistant.

An incision is made 1″ to the outer side of the ridge of the tibia. The incision is made rapidly through the skin and fat down to the tibialis

anticus muscle. The skin and fat are dissected up rapidly exposing the tibia. The length and shape of the graft is again measured with a flexible probe deep down in the incision through the spinous process. The operator places the probe on the periosteum of the tibia and cuts an outline on the periosteum corresponding to the curve and length of the graft desired. It is as well to cut the graft about 1″ longer than is necessary. The graft is cut by a mechanical saw or a sharp osteotome. Just before removing the graft from the bone, the operator uncovers the incision over the spine and makes sure that it is ready to receive the graft from

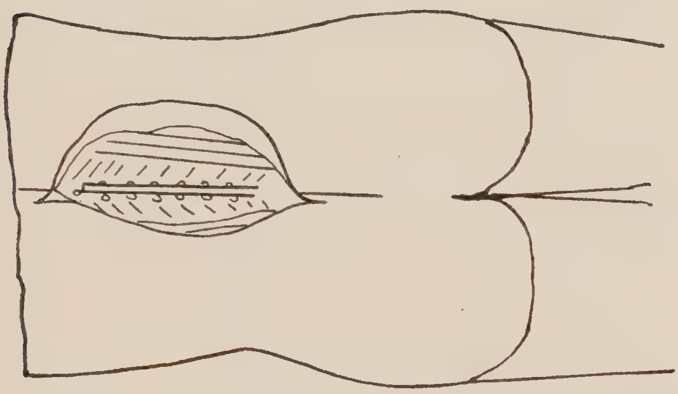

Fig. 428.—The graft is placed between the split bone and the split ligaments.

the tibia (see figures 427 and 428). The graft is then placed between the split spinous processes for the full length of the incision. By cross cuts in the graft (see figure 429), it may be curved to fit any angle. The periosteum is sutured firmly over the graft with interrupted chromic catgut sutures number 1 or kangaroo tendon (see figure 430). The operator should suture one end and work up toward the other. The periosteum should not be everted or inverted as is often the case. When the periosteum and muscle layers have been brought together with interrupted chromic catgut, the muscles on either side may be folded over and held by interrupted chromic catgut sutures number 0 over this, the fat is sutured with interrupted chromic catgut and the skin with continuous chromic catgut. When the skin is closed, two large pads of sterile sheet wadding are placed one on each side of the incision (see figure 431). A small strip of sheet wadding is placed over the pads. The plaster shell is now placed on top of the patient, the padding well adjusted, a swathe is placed under the patient and passed around the plaster shell holding it firmly in place. The patient is then rolled on his back with the plaster shell in place. A Bradford frame is brought to the side of the operating table on a truck. The patient should be disturbed as little as possible for five days. In using the bed

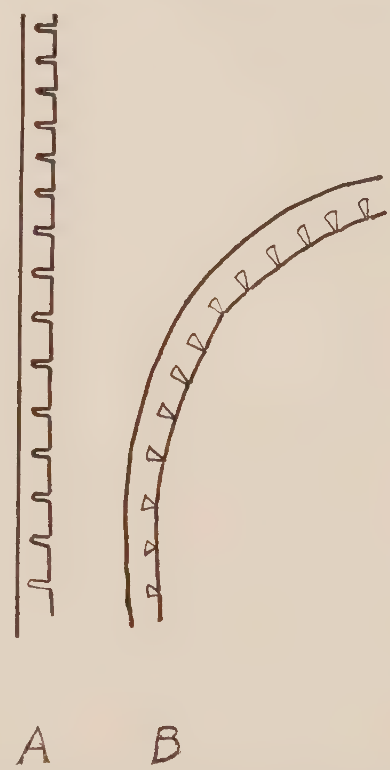

Fig. 429.—Method of sawing slots in a graft used when necessary to make it pliable. Albee operation. A, Shows the slots sawed through. B, Shows the possibility of bending the graft so that it will fit.

pan, the Bradford frame may be raised without disturbing the patient in the shell. As a rule no dressing is necessary until the third or fourth week. In some instances a window is cut out in the posterior shell at the time it is made to allow dressing without disturbing the patient. At the end of six weeks a plaster jacket or a brace is applied and the patient allowed to sit up in bed. The patient is gradually gotten up and allowed to walk. At the end of six months the apparatus may be discarded.

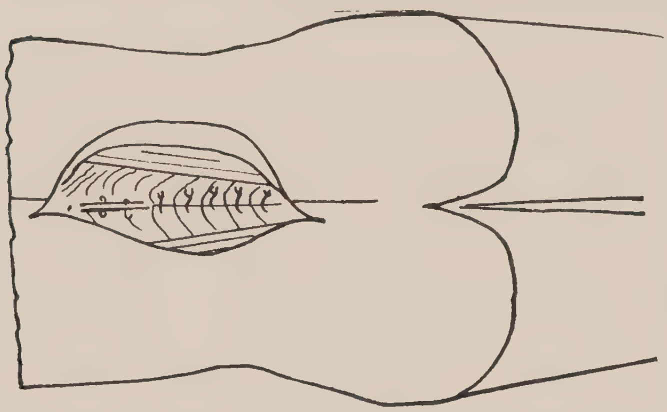

Fig. 430.—Sutures are placed holding the graft at either end and then other sutures are placed between it holding it firmly in place.

322. Operation for Obtaining Ankylosis of the Spine. Hibbs Operation. — The patient is brought into the operating room on a Bradford frame lying in a posterior plaster shell which has been made several days before and which holds the spine in the position which the operator wishes the spine to be after the operation. This plaster should not only have been made several days before but should be tried on and found to be comfortable before using it at the time of operation. The patient is put on the operating table and when anæsthetized is turned on his abdomen. The surgeon marks lightly on the skin with a scalpel the upward and the lower limit of the spine to be immobilized.

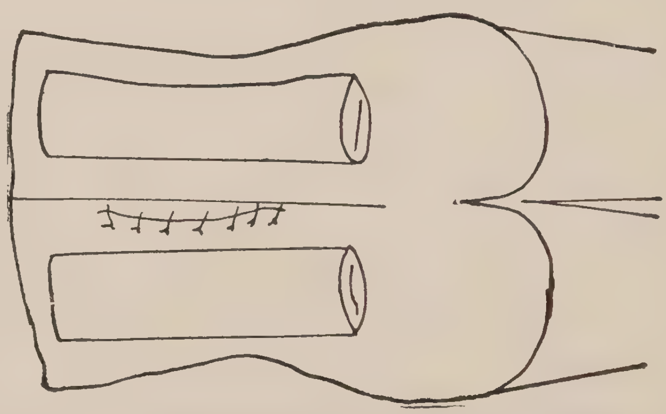

Fig. 431.—Folded sterile sheet pads are placed on either side of the incision.

An incision is made slightly above and extending slightly below these marks. The incision should be carried vertically through the skin and subcutaneous fat one-half inch to the side of the spinous processes and parallel to them. This is retracted; the operator now incises the periosteum over the spinous process down to the tips of the bone from one end of the incision to the other. This incision is carried through the inter-spinous ligament continuously with the periosteum which is to be removed from either side of the spinous process. In other words, the periosteum is removed from the tip of the spinous process down on either side of the process continuously with half of the inter-spinous ligaments. The periosteum on the upper and under surface of the spinous process is removed at the same time. The dissection is carried well forward freeing the lamina on both sides. The operation is done satisfactorily when the operator can clear the periosteum on both sides con-

tinuously with the ligaments, separating the periosteum from the ligaments hardly at all. The tip of each spinous process is carefully inspected to see that it is denuded of periosteum. The under side and the upper side of the spinous process are also carefully inspected and cleared again, if necessary, of any remaining bits of periosteum. The lateral articulations are curetted. The spinous processes are then cut at their bases and bent down so that the tip of each spinous process above touches the cut base of the spinous process below (see figure 432). There is then a continuous bony ridge made by the touching of the cut base of one spine and the fresh tip of the next process from one end of the incision to the other. Small portions of the lamina which have been denuded of periosteum may be split off and folded across to the lamina above and below. The periosteum and ligaments which were removed en masse from the two sides of the spinous process are now brought together covering the bone completely. Heavy chromic

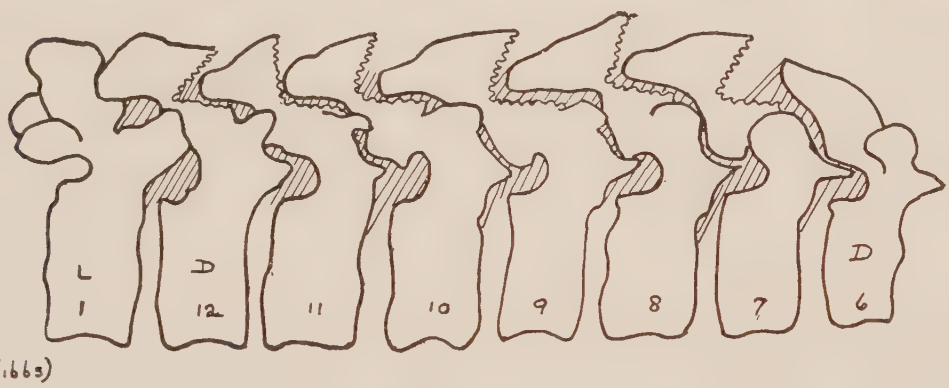

FIG. 432.—Method of cutting and overlapping the spinous processes. Hibbs operation.

catgut sutures or kangaroo sutures are used to bring these tissues together. The deep tissues are brought together with interrupted chromic catgut sutures number 00, the subcutaneous fat with interrupted chromic catgut sutures number 00, the skin with continuous chromic catgut. Certain precautions are necessary in this operation. There is a good deal of ooze from the bone but practically no bleeding of any consequence if the operator is careful to make his dissection with a large and a small osteotome so that the work is done subperiosteally. The operator should clear one side of the spine working from above downward or from below upward and then clear the other side. In doing this as he goes downward large strips are packed between the periosteum and the denuded spine. This will stop the bone ooze. The operator denudes the spinous process with the ligaments attached to the periosteum all in one piece. Strips are packed and then he works downward to the end and then he works upward packing the space he leaves, and uncovering the way he is going, working off the periosteum and the ligaments deeper and further forward. With each succeeding step the operator will see more clearly the outlines of the spines and laminæ. Having cleared one side of the spine well forward, the operator

packs the space between the periosteum and the spine with strips and works on the other side of the spine. In bringing together the periosteum over the bent down spinous processes, the periosteum and muscles, especially in adults where they are large, will be found to be rolled in. It is important to unroll the mass of periosteum and muscles to which it is attached before placing the sutures in order to be sure that the removed periosteum comes again in contact with the bone. When the skin is closed two large pads of sterile sheet wadding are placed one on each side of the incision (see figure 431). A small strip of sheet wadding is placed over these pads, the plaster shell is now placed on top of the patient, the padding well adjusted, a swathe is placed under the patient and passed around the plaster shell holding it firmly in place. A Bradford frame is brought to the side of the operating table on a truck, the patient and shell are rolled over so that the patient lies in the shell on the frame. The patient should be disturbed as little as possible for five days. In using the bed pan, the Bradford frame may be raised without disturbing the patient in the shell. As a rule no dressing is necessary until the third or fourth week. In some instances a window is cut out in the posterior shell when it is made to allow dressing the wound without disturbing the patient. At the end of six weeks a plaster jacket or a brace is applied and the patient allowed to sit up in bed. The patient is gradually gotten up and allowed to walk. At the end of six months the apparatus may be discarded.

323. The Carrell-Dakin Technique for the Treatment of Suppurative Cases, Compound Fractures, Etc. The use of the Dakin solution (Desfresne modification) has improved remarkably in the method of treating not only deep but superficial suppuration both recent and advanced. Recent wounds may be sterilized; pus cavities and old infected compound fractures are made clean in a very short time. Superficial pus cavities are clean enough for suture in from four to fifteen days. Deep-seated, badly infected wounds or extensive neglected compound fractures requiring amputation may be rendered clean and healthy in from fifteen to twenty-five days without amputation. In seven days there is usually a very marked improvement. A record of the severity of the infection is made by making smears from various parts of the wound. These are taken daily, stained with any stain such as methylin blue put under a one-twelfth oil emersion. The bacteria are counted regardless of kind. They are at first innumerable. In seven days they are usually tremendously reduced. When they amount to two or three organisms to four or five fields and remain so for five days, the wound may be sutured and heals by first intention. This is the result in the worst of war wounds treated by this method. Death, amputation and prolonged suffering are all greatly reduced. All surgeons should become familiar not with the principles but the exact detail of this technique. The result in any given case, it is estimated, is that the solution counts 20

per cent and observance of the technique 80 per cent. The detail is most important, first in the making and preserving of the solution; second, in the treatment of the wound, making large open cavities which can be dressed advantageously by this method following the removal of all foreign material or destroyed tissues excepting bone; third, the technique in the care of the skin about the wound, and of the wound itself; and fourth, the closure of the wound, whenever possible, at the proper time. Cases that would require from three to six months to heal can be healed in from four to six weeks, often in much less time.

(a) The Dakin Solution * (Desfresne Modification).

The solution is made up of sodium hypochlorite free from caustic alkali containing 0.45 to 0.50 per cent hypochlorite. Under 0.45 per cent is too weak. Above 0.50 per cent is irritating. It must not be heated, not placed with alcohol, not used in the eye, nor intravenously.

(b) Preparation of the solution.

With chloride of lime (bleaching powder) having 25 per cent of active chlorine, to make 10 litres of solution; the quantities are as follows:—

200 grams chloride of lime
25 per cent active chlorine
100 grams sodium carbonate
dry (soda of Solway)
80 grams sodium bicarbonate, dry.

These ingredients are put in a 12-litre flask as follows:—

5 litres of water and 200 grams of chloride of lime, shake vigorously until no parts float and all is dissolved; leave from six to twelve hours.

At the same time dissolve in 5 litres of ordinary cold water the carbonate and bicarbonate of soda. Let this stand from six to twelve hours. After twelve hours the soda solution is poured into the solution of chloride of lime; shake vigorously a few minutes. Allow the calcium carbonate to be precipitated; in half an hour, siphon the liquid and filter it with a double blotting paper, to obtain a good clear liquid. The stock solution is kept in blue and brown bottles well corked. It should be kept tight, kept cool and in the dark.

(c) Testing the chloride of lime for chlorine.

This must be done every time a new product is received. To determine the active chlorine in the bleaching powder, titration of the chloride of lime must be done. Take small quantities from different parts of the jar of bleaching powder, weigh out 20 grams, mix in one litre of tap water, leave in contact a few hours;

Take 10 cu. c. m. of the clear liquid, add to it
10 cu. c. m. of a 10 per cent solution of potassium iodide
2 cu. c. m. of acetic acid.

* Surgery, Gynæcology and Obstetrics, Volume XXIV, Number three, March, 1917, page 255. Dr. Sherman's article has been freely quoted in obtaining the data for the solution.

Put into this mixture, drop by drop, a decinormal solution of hyposulphite (2.48 per cent) until decolorized.

The number N of cu. c. m. of this solution used multiplied by 1775 will give the weight N of active chlorine contained in 100 grams of the specimen of chloride of lime.

(d) Making the solution with other chloride of lime than that containing 25 per cent of chlorine.

It will be necessary to reduce or enlarge the proportion contained in the preparation. This is done by multiplying the three numbers, above mentioned, 200, 100 and 80 by the factor 25 N, in which N represents the weight of the active chlorine per cent in 100 grams of the chloride of lime used.

(e) Testing the Dakin solution for the amount of hypochlorite of soda it contains.

Titration of the Dakin solution:—

measure 10 cu. c. m. of the solution
add 20 cu. cm. of potassium iodide 10 per cent solution
20 cu. c. m. of potassium iodide 10 per cent solution
2 cu. c. m. of acetic acid

Drop by drop add a decinormal solution of sodium hyposulphite until decolorized.

The number of cu. c. m. used multiplied by 0.03725 will give the weight of the hypochlorite of soda contained in 100 cu. c. m. of the solution. It should contain from 0.45 to 0.50 per cent of hypochlorite of soda. Under 0.45 per cent it is too weak, over 0.50 per cent it is irritating or burns the skin.

(f) Testing the alkalinity of the Dakin solution.

Pour 20 cu. c. m. of the solution and drop on the surface of the liquid a few centigrams of powdered phenol phthalein. The correct solution does not give any color.

Lebarrague's solution and Eau de Javel will give an intense red color, showing in these two solutions the presence of caustic alkali.

(g) Difficulties of the Dakin solution.

Unstableness of the bleaching lime varying in active chlorine from 15 per cent to 37 per cent which gives some trouble in making the solution. Much of the sodium bicarbonate is really sodium carbonate, making it difficult to neutralize the solution. If it is alkaline or caustic it will burn the skin and irritate the tissues. It must be neutralized by sodium bicarbonate. It must be frequently and thoroughly tested on account of its unstableness and tendency to become caustic. It must be from 0.45 to 0.50 per cent hypochlorite;—more makes it burn and irritate, less makes it too weak.

(h) Solutions similar to the Dakin solution,—more stable but not yet proved to be as good.

Chloramine (Boots) and chlorazene (Abbott)—paratoluene sodium

sulpho chloramide. This contains chemically combined chlorine acting similarly to Dakin's solution. It is more stable and will perhaps be found more satisfactory where there is no facility for making the Dakin solution, or in hot climates.

(i) First aid dressing of the wound.

The skin should be painted with iodine, 3-½ per cent, at the trenches, or where wounded. The Dakin solution should be injected into any small wound. If wide or open, the wound should be packed loosely with gauze and filled with the Dakin solution.

(j) Operation.—Preparation of the wound for treatment.

As soon as the condition of the patient allows he is anæsthetized. Free incisions and explorations are made for foreign bodies of all wounds as early as possible. X-rays are taken beforehand, if possible. The shell tracts are opened and any devitalized tissue excised. Carrell tubes (see figure 434) are placed to the bottom of the cavities; gauze is placed loosely between the tubes. The solution is injected into the wound to see the amount necessary to fill the cavity with the gauze in place. The surgeon should see that it flows readily to all parts. The actual contact of the solution with all of the tissues is vital to its success. Moreover, the wounds should be made so large and accessible to every part that, not only the tubes, but the gauze may be removed every twenty-four hours and fresh gauze, or gauze and tubes easily replaced to the remotest corner with little pain, using dressing forceps only. The strictest asepsis is essential in dressing the wounds.

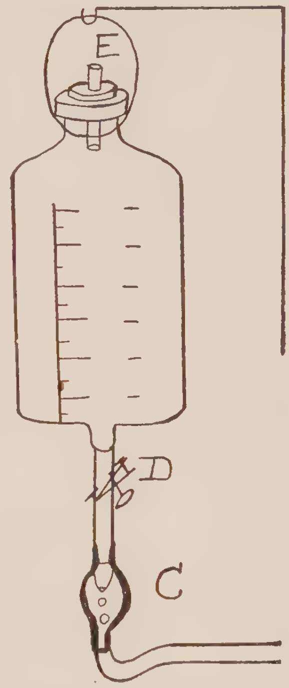

FIG. 433. — Vessel for containing Carrell-Dakin solution and rubber stopper.

Over the dressing is placed a non-absorbent cotton pad but before this, gauze saturated in liquid vaseline, and sterilized, is placed on the skin around the wound. This is done to protect the bed and clothing from the bleaching and destruction of the chlorine. The whole leg is bandaged with non-absorbent cotton, or Turkish toweling.

(k) Dressing and after care.

Every two hours night and day the wound is saturated with the solution. The amount used is carefully noted on the graduated vessel at the head of the bed. The necessary amount is noted and prescribed. The dressing should be saturated, as noted at the time of operation. If there is pain the vessel should be lowered. When the dressing is done, the gauze is changed and fresh sterile gauze is placed in the wound around the tubes. The gauze is placed loosely and must not occlude the tubes, or press or bend them. It should not be dragged on the skin, or touched with the hands; for this reason the wound must be made very large and wide open at the time of operation. The remotest corners must be carefully cared for and the tubes arranged to reach

every part of the cavity. In large, or small, superficial wounds, the tubes are laid lengthwise. Either dressing or artery forceps may be used, but the hands should not touch the wound, gauze or any material. When the tubes and gauze are arranged in the wound, a measured amount of the Dakin solution is allowed to saturate the wound and the amounted noted. The skin is cleaned with ether, a neutral sodium oleate is applied over the skin, followed by sponging with the Dakin solution, and then the sterile gauze containing vaseline is applied over it around the wound. Over this is placed the dry non-absorbent cotton about 3 c. m. in thinkness.

The dressing is done every twenty-four hours but in emergency, may go two or three days. The saturation with the Dakin solution must be continued every two hours, night and day. The intermittent saturation seems to be more satisfactory than a constant drip. It takes at least two weeks to master the details of this technique. Re-infection is easy, and may come from lack of care of the skin, or the failure to observe any detail.

(l) Microscopic examination of wound smears.

A one-twelfth oil emersion is used. Smears are prepared in the usual way and stained with almost any simple stain. For the first six days enormous numbers of organisms are present and enormous numbers of polymorphonuclear leucocytes. After the seventh day, the organisms decrease markedly, small mononuclears appear instead of the polymorphonuclears. The appearance of macrophagers after the tenth or eleventh day is considered a very good sign. The bacteria constantly decrease, the cocci remaining the longest. When there are but two or three bacteria in five fields and this condition persists for five days consecutively the wound may be sutured and heals by first intention. It is said to be safe to do a bone graft two weeks after the wound is healed. It is probably better to wait two months.

The solution is non-toxic regardless of the amount used, it will abort infection, and control well established suppuration. Its success depends upon the Carrell detail.

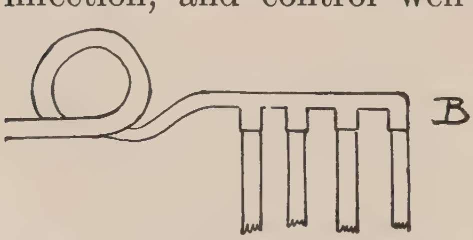

Fig. 434.—Rubber tubes from the wound are attached to a glass distributor.

(m) The apparatus and material necessary. (See Figs. 433 to 435.)

(1) A vessel for containing the solution. The vessel is suspended three feet above the patient. It should be graduated and empty not at the side but at the bottom, so that it may all be emptied. It should be closed with a rubber cork through which a glass thistle (E, figure No. 433) is fitted, with sterile cotton in its end. In this way the air may enter but no chlorine is apt to escape.

(2) The tubing should be pure gum rubber to withstand the chemical action of the solution, five millimeters in diameter, one millimeter thick, making the internal diameter three millimeters. It is cut from 15

to 25 c. m. long. The tubes should be good enough rubber so that it may be tied with pagenstecher at its distal end and not leak. The tube is perforated at its distal end with a leather punch through both walls at once. The holes should be every 1-½ millimeter, six to ten pairs of punctures in all. The holes at one level are at right angles to those above and below. All of the plugs should be removed.

(3) A glass drip (C, figure No. 433) similar to that used for rectal salt solution is fastened to the rubber outlet pipe from the Dakin solution. This should be six millimeters in diameter.

(4) Distributors of glass (A & B, figure No. 435) so that one, two or four tubes may be attached to each distributor. The distributors are attached to the numerous tubes in the wound, one end being reserved for the supply tube to which the glass drip is attached with a regulator clamp above it. The bottle is placed three feet above the patient.

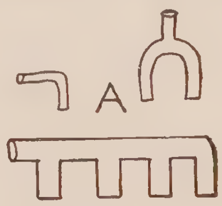

FIG. 435. — Other forms of glass distributors with two or three or more openings.

(5) A regulator clamp attached above the glass drip. (D, figure No. 433.)

(6) Gauze soaked in liquid vaseline and sterilized; then cool. This is used around the skin to prevent leaks.

(7) Sterile gauze to pack lightly in the wound and to use in the dressing.

(8) Non-absorbent cotton to envelop the limb and to place over the sterile gauze used in the dressing.

(9) Ether to wash the skin about the wound.

CHAPTER II

PLASTER OF PARIS AND BRACES

324. The Application of Plaster of Paris Bandage.—Plaster of Paris bandages, three, four and five inches wide are more useful than any other sizes. While applying a plaster the water should be frequently changed, a bucket full for every eight plasters. The water becomes super-saturated after that.

Sheet wadding rollers should be made three or four inches broad and rolled one thickness at a time. In this way they may be placed in close position to the patient and rolled snugly, making the outlines of the body distinct. This is essential in dealing with deformities. It is impossible to apply a well fitting plaster over carelessly applied sheet wadding. The leg should look like a leg, the arm like an arm after the application of sheet wadding. A liberal amount of snugly fitting sheet wadding should be used. A plaster of Paris bandage should be light, re-enforced when necessary at certain places. Deformities and contractures should be over stretched and the joints returned so nearly to normal at the end of the operation that no force will be necessary during the application of the plaster. Heavy plasters are necessary after operations on the hip in heavy patients to allow them to be moved without breaking the plaster. Such plasters should be heavy where they are apt to break; the re-enforcement is made by plaster ropes.

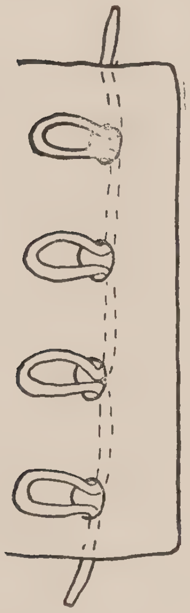

Fig. 436.—A method of lacing a plaster of Paris jacket or leg plaster. Holes are made one or one-half inches to two inches from the edges of the plaster three inches apart. Raw hide or heavy cord is passed through the loops. (See figures 461 to 464.)

In making plaster ropes, the end of the soaked plaster bandage is held in one hand and the bandage unrolled to the length desired. This length is measured off repeatedly over and over until the bandage is used up. The operator holds between his hands the plaster bandage unrolled the length desired. This is passed through his closed hand and squeezed firmly together into the shape of a rope. In doing this all parts of this plaster bandage come firmly in contact. The rope is then applied while it is soft and pliable to the plaster on the patient at the point where re-enforcement is needed. The operator flattens the rope into the plaster leaving it round wherever it is used to bridge over a space. Plaster bandages are applied over the rope, incorporating it in the plaster. The plaster should be split on both sides shortly after the

operation and strapped on with webbing straps and buckles or with adhesive straps or tied with a wet bandage. A window should be cut over the incision to allow it to be inspected without disturbing the plaster. Plaster ropes may be used to re-enforce where large windows are necessary (see figures 450 to 460). If there is much swelling, the plaster is loosened and the front half lifted so that the finger may be passed between the halves from one end of the plaster to the other on the sides. If there is still much swelling, the front of the plaster is removed and the sheet wadding opened, exposing the skin along the whole length of the limb. A well padded plaster is comfortable. There should be no pain excepting that coming from the operation. Bone operations are rendered very much less painful if the surgeon is careful in the manipulation of the bone and avoids being rough when force is necessary.

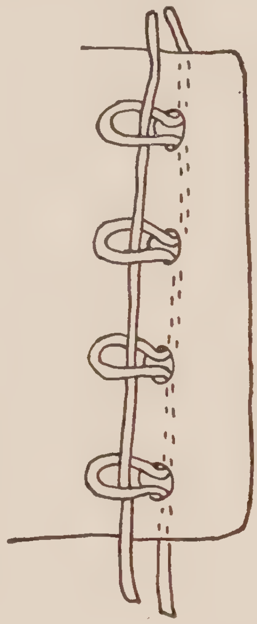

Fig. 437.—Another heavy cord is run through the loops of the first cord.

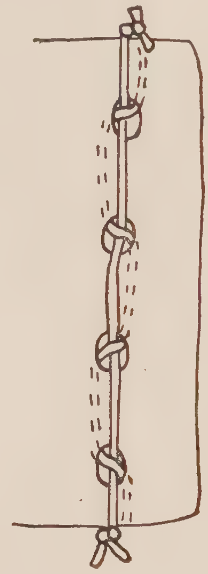

Fig. 438. — Both cords are tightened and tied at each end.

325. Lacing a Plaster.—When a plaster is to be removed and reapplied, a temporary method of lacing the plaster has been found very convenient (see figures 436 to 440). The plaster is removed, holes are made with a big awl two or three inches apart one or two inches from the edge of the plaster. The holes should be made one-fourth inch in diameter so that an ordinary shoe lacing can be passed through the hole, double. A long cord or lacing is placed on the under side of the plaster (see figure 436) and loops from it passed up through each hole. A second lacing is passed down the outside of the plaster through the loops. The under lacing is then pulled tight holding the outside lacing which is also stretched tight (see figures 438 and 439). The lacings are tied together at the ends of the plaster; a set of holes and two lacings have been

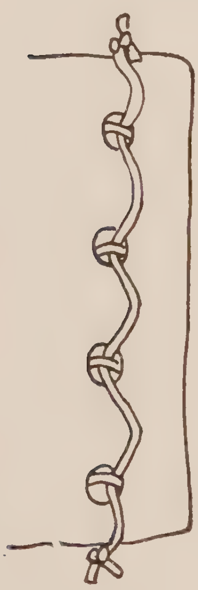

Fig. 439. — The cord between the holes is tight but loosens enough to act as a loop for the lacing. (See figure 440).

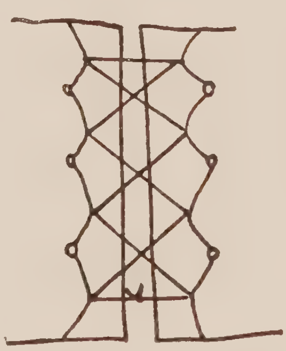

Fig. 440.—A lacing is used from side to side to hold the plaster together.

applied along each edge. When the plaster is reapplied there will be a loop of lacing every two inches along each edge. The loops are used as eyelets, an ordinary lacing passed through them holding the plaster together (see figure 440).

326. Plaster of Paris Bandage for Neck or Head, Neck and Thorax. Method of Applying "Plaster Ropes" (see figures 420 to 422).—In applying a plaster of Paris for the head, neck and thorax, a light plaster should be put on the thorax and another on the head in the following way:—sheet wadding and a stockinet cover the head and neck except the face, a band of plaster connects the forehead with the occiput, another band goes in front of the ear under the chin and over the top of the head. A thickness of felt is placed under each band. The plaster should avoid the ears. The thorax is covered with sheet wadding, and felt straps three inches broad and twenty inches long over each shoulder. Over each of these is placed a flattened plaster rope. A light plaster is then put on the thorax, the plaster ropes are flattened and included in the plaster. The four ends are turned up and looped into the thorax plaster as it is applied; the head is now held in the desired position, a plaster rope is placed on each side extending from the front of the thorax up over the shoulder rope connecting with the plaster in front of the ear. A third extra heavy rope extends from the plaster on the occiput to the middle of the back or to the back of a shoulder strip. These ropes should be flattened on the thorax. They are made as long as necessary and one inch by one and one-half inches broad; the double rope behind is twice this size.

Fig. 441.—Plaster jacket. Note the window over the abdomen, the back of the jacket extending to the bottom of the sacrum. Under the arm, the plaster cut out allowing plenty of room along the posterior axillary line. The jacket is vertical at the anterior axillary line and extends straight up to the clavicle.

The ropes are applied when soft and rubbed well into a round shape. They are flattened wherever they are in contact with plaster. The round part of the ropes may be covered over with plaster bandages which are placed over them and extend downward to the main part of the plaster.

327. A Plaster of Paris Jacket.—When a plaster is applied to hold the spine, a thick undershirt is worn. The anterior spines and the crest of the ilium should be well padded with felt, also the sacrum and the front of the chest and axilla. The plaster is applied over this and re-enforced so that a large window may be cut over the abdomen (see figure 441). The plaster may be slit on the two sides and laced as described above (see figures 436 to 440), or it may be slit in front and laced here. If the plaster is to be laced at the two sides, in cutting the plaster two angular cuts should be made on each

side (see figure 461) in order that the sides will fit and the plaster not twist.

The top of the plaster should reach as high as the collar bone in the middle and in front of the shoulder; large cuts are made at the side for the arm so that it is not held up by the plaster. Below, it should cover the whole of the sacrum behind so that in sitting upright it is one inch off of the chair. In front it covers the anterior superior spine about one inch and is cut up to allow right angle flexion of the hip.

328. The Plaster Cuirass.—Where an operation is performed on the shoulder or hip in a very heavy person, the body portion of the plaster may be applied with a double swathe posterior and a plaster of Paris bandage, anterior. This plaster is continuous with the leg or arm as the case may be and holds the hip or shoulder.

Plaster cuirass for the shoulder (figures 318, 319, 320)

The arm is abducted and outwardly rotated, a double swathe of unbleached cotton passed under the thorax; this is slid up so that it will reach a little higher than the clavicle. The swathe is torn at the side making about eight many tails (see figure 319) each one and one-half inches to two inches broad. They should be torn to the posterior axillary line on either side. As the swathe is doubled the tails are double making eight pairs of tails. Sheet wadding is placed over the chest and shoulders and around the arm and hand. A heavy sheet wadding pad six inches broad is placed on either side of the chest from the axilla down. The plaster of Paris is applied over the thorax in two layers, the third layer reaches over the side of the thorax and is caught by a double many tail near the posterior axillary line, the plaster bandage loop resting on the thick sheet wadding pad. The plaster bandage is carried to the opposite side and is caught there in like manner; the bandage is carried over the thorax, being caught on one side and the other, until it has been looped all the way down on each side, around each of the double tails. The plaster is applied and re-enforced on the front of the thorax. It is then looped again around the many tails on either side. Two layers of plaster of Paris are placed on the arm and shoulder and two heavy ropes of plaster are made one inch thick and two inches broad. These are put along the arm together and reach over the thorax where they are divided like an inverted Y (figure 320) one down the front of the chest, the other diagonally. These ropes are flattened into the plaster. More plaster is put over the arm and hand and thorax, finishing the plaster.

When the plaster is complete, each many tail is pulled through its plaster loop (consisting of three or four turns of plaster). In this way the posterior cloth is made tight and smooth.

The two upper tails are placed too high to be incorporated in the plaster at the side. They are brought over the shoulder, two double tails, over each shoulder and incorporated in loops of plaster at the top

during the application of the thoracic part. These tails are now tightened and tied to each other, two on the right and two on the left. At the side when the swathe tails have all been tightened on the right, the upper two are tied to one from the next plaster loop, the other is tied to one from the next loop below and so on until finally the lower one from the last loop but one is tied to the two from the last loop. On the left side the tails are now tightened, drawing the cloth smoothly behind. The tails are tied as described above. In this way one-half of each tail goes up, the other half down to be tied to half of the next tail. The last tail at the top and the last at the bottom are not divided.

329. Plaster Cuirass for the Hip (see figures 318 to 320).—The thoracic, abdominal and pelvic portion of the plaster is applied as described for the shoulder. The double swathe made of unbleached or tough cotton reaches over the buttock upward to the nipple line. The plaster is re-enforced on either side of the abdomen and also across the thorax and across the pubic bone, so that a large window may be cut over the abdomen without weakening the plaster. When two layers of the leg plaster are applied, four heavy plaster ropes are made, one inch by two inches broad and two feet long; one reaching from the side and nipple line, one from the middle front of the thigh to the waist, and another curving over the pubic bone, a fourth from the middle of the thigh in front to the extreme side of the plaster and reaching to the waist. These ropes are flattened and moulded into the underlying plaster. More layers of plaster are then put on the body plaster and leg plaster until it is completed. These re-enforcements should be placed so that windows can be made in the plaster allowing the incisions to be dressed without disturbing the plaster. The leg portion is split at either side down to the toes.

The plaster is not only useful for fasciotomies at the hip and operations on the shoulder or hip in infantile paralysis but in many other orthopedic conditions. In impacted fracture in old people the cuirass may be applied without disturbing the patient lying in bed. The double cloth is passed under the body; the leg gently abducted and held there, moving the patient just enough to have the leg off of the bed.

One assistant holding the leg or arm is all that is necessary for the application of this form of plaster.

When a spica board and many assistants are not available, it will be found a very convenient form of plaster, especially when the patient is heavy. For any one used to handling plaster of Paris it is easy to apply.

330. Plaster of Paris Bandage for the Hip. (See figure 450; see also Plaster Cuirass for the Hip, and Congenital Dislocation of the Hip Plaster).—In the application of a short plaster spica the anterior spines should be well padded and also the sacrum. In lying down it is difficult to be comfortable unless there is plenty of padding over the sacrum. A heavy felt pad should be used here. About twelve folds of sheet wadding are equal to a good felt pad.

Where an operation has been done on the hip it is better to include the thorax and the leg and foot (see figures 27 to 29). In applying a plaster to the thorax and leg there should be felt pads over the anterior spines and sacrum in addition to the usual sheet wadding which is applied from the toe to the axilla. The plaster should fit snugly and be re-enforced over the pubic bone, over the back of the hip double, over the front of the thigh and hip and pubic bone and finally on either side and above the abdomen. These re-enforcements consist of one plaster rope one and one-half inches by one inch wide. A large window is cut over the abdomen in order that there shall be no pressure here. The plaster is split at each side and held together by adhesive or webbing straps. A short hip plaster for walking may be applied later on. This includes the pelvis and the leg as far as the knee. This should be well padded and may be made to lace on both sides of the leg and both of the pelvis as described above (figures 436 to 440).

When a hip plaster is applied to hold abduction or flexion or hyperextension, it is important that a few turns be taken around the thigh of the opposite leg to make sure that the pelvic portion cannot ride up on that side. After ten days or later when the patient begins to sit up this portion of the plaster is removed.

331. Plaster of Paris for Congenital Dislocation of the Hip.—Following the operation for congenital dislocation of the hip a plaster of Paris bandage is applied as follows:—stockinet or other suitable covering is applied to the pelvis and the legs. Felt pads are applied over the anterior spines, over the top of the trochanter, under the sacrum and over the internal condyles of the femur. A well fitting plaster is then applied over the thighs and pelvis for a double case or in a single case over one thigh with a few turns over the other to prevent the pelvic portion from slipping up. Heavy plaster re-enforcement or plaster ropes are placed in front over the pelvic bone (see figures 5 to 7) along each thigh and in front to prevent the breaking near the anterior spine. A similar re-enforcement is placed behind it on the sacrum and down the back of the thigh (figures 11 to 14). More plaster bandages are used to bind this re-enforcement to the rest of the plaster. The thigh of the dislocated hip or hips should be parallel to a line connecting the anterior spines and if possible the knees should be above this line and posterior to it. This will show good overcorrection.

The plaster should pull the trochanter down and hold it firmly. The tuberosity of the ischium should be held firmly and be well padded. When the part of the plaster, including the pelvis and thigh and knee, is hardening, padding is applied to the lower leg and foot and the plaster continued downward, the foot being held at right angles.

It is important to maintain the desired position of the thigh and have the plaster harden immediately, maintaining the Mueller or Lorenz position while completing the plaster down to the foot. The plaster

should be split into an anterior and posterior half as shown in figures 11 to 14, and laced as shown in figures 436 to 440.

332. Application of a Hip Plaster of Paris after Fasciotomy. Or After Osteotomy of the Hip or Trochanter.—It may be as well to go more into detail as to the application of plaster. A loose ill-fitting plaster does not hold the patient or the bone. The sheet wadding should fit the leg snugly and the body perfectly. After the application, the outlines of the patient should be distinct and shapely. A pad of heavy felt is placed over the sacrum, another one over each anterior spine. A thin layer of felt covers the chest from the posterior axillary line laterally and reaching down to the lower edge of the ribs. The sheet wadding should be applied lavishly but firmly all over the patient and it should fit snugly. A large thick felt pad is placed over the tuberosity of the ischium and the perineum of the affected side (see figure 30). A long rope of plaster is applied over this felt holding the felt against the tuberosity of the ischium. This plaster rope should be long enough to extend to the axilla in front, to the axilla behind (see figures 59 and 60). Its ends are held by a nurse during the application of the plaster to the back. This plaster rope should be used after osteotomy or fractures at the hip. The plaster is then applied to the leg as far as the knee, the knee being well padded with felt in addition to the sheet wadding. The plaster should then be re-enforced heavily in the front of the leg and hip, again over the pubic bone and front of the leg, again on the front up to the nipple. Additional re-enforcement should be made on the side of the leg well posterior and extends well up to the thorax. In a heavy person each of these re-enforcements should be one inch thick and two inches wide (see figure 28). Further re-enforcement of plaster is made across the front of the chest, the sides of the abdomen and over the pubis, marked by lines (see figures 28 and 29). The plaster is finished rapidly down from the axilla to the knee on the unaffected side and down about six inches on the opposite thigh. As soon as the plaster has hardened the traction is removed gently from each leg. Sheet wadding is applied around the foot and ankle on the affected side and the plaster is completed from the toes to the knees. The plaster is cut out over the abdomen and behind as high as the upper sacrum. The pelvic portion should be very heavy. The patient should lie in bed with the buttocks resting on the bed and the operated leg off of the side on the bed in order to maintain the hyperextended position of the hip, unless he is placed on a Bradford frame held above the bed. If there is too much pressure on the chest, the leg is lowered. In this way there is no danger of losing the hyperextended position of the leg. Plasters should be split, "bi-valved," on both sides of the leg and foot and tied with a wet bandage or strapped with webbing straps or adhesive. It is often necessary to use sedatives for the first five days, when the correction has been considerable. They should be given rather than withheld for pain or restlessness. After

five days a well padded plaster will be perfectly comfortable. The patient lies on his back for five weeks and then is sat up in the original plaster. In sitting, the good leg is flexed, the other reaches over the edge of the bed. At the end of the sixth or seventh week the patient is stood up a little at a time and finally at the end of the eighth or ninth week he walks on the good leg with crutches and assistance. The plaster is cut so that the knee portion may be removed posteriorly and allow a little motion here. When he is able to stand without showing any weakness, the plaster is removed and a light plaster applied with

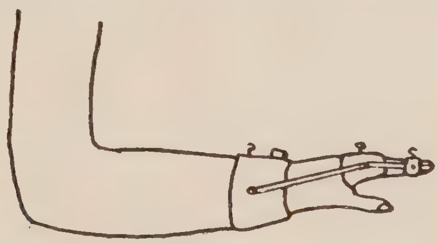

Fig. 442.—Side view of apparatus applied without elastic bands.

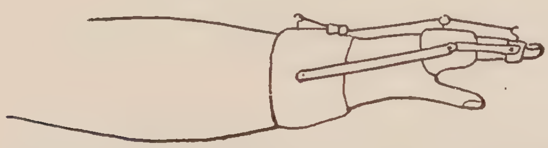

Fig. 443.—Elastic straps applied to the hooks of the apparatus to overcorrect finger flexion, side view.

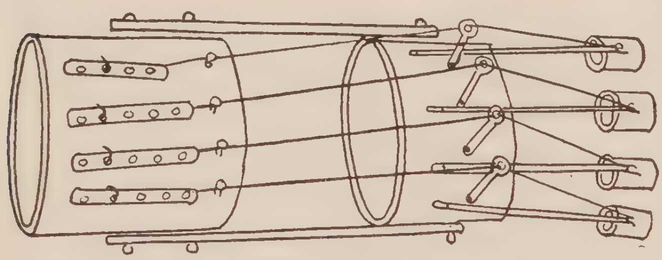

Fig. 444.—Dorsal view of post-operative apparatus to correct finger flexion. (Note attachment of elastic bands from each finger to the wrist).

Fig. 445. — A finger splint for stretching in hyperextension the metacarpo-phalangeal or for the phalangeal joint. The cord reaches around the upper arm. (See figure 446).

the patient standing and holding on to his crutches. This position is preferable to one lying down when the plaster is to be used for locomotion.

333. Retaining Apparatus after Operation on the Hand (442 to 446).—In claw hand and deformities of the finger the same plaster apparatus may be used as described for hammer toe. In the case of a hand, it is more convenient to use a wire splint or aluminum splint with a point for each finger bent to correct the deformity, the wrist should be flexed or extended and it should always include the flexed elbow in order to maintain good position of the hand and wrist. For hyperextension of the fingers and wrist, the palm of the hand is usually placed upward, the splint on the palm of the hand. For flexion of the fingers and wrist the palm is placed downward, the splint on the back of the hand. This will

necessarily vary according to the condition. It is usually convenient to have the elbow part of the splint separate from the wrist and hand splint. The former is applied to the arm and forearm, the latter overlaps the former about four inches in the forearm. The hand and finger

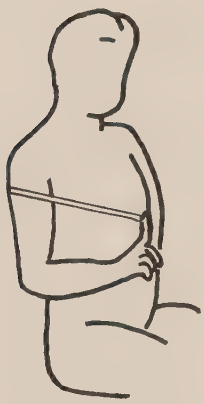

FIG. 446.—Method of applying the string around the upper arm when using the splint. (See figure 445).

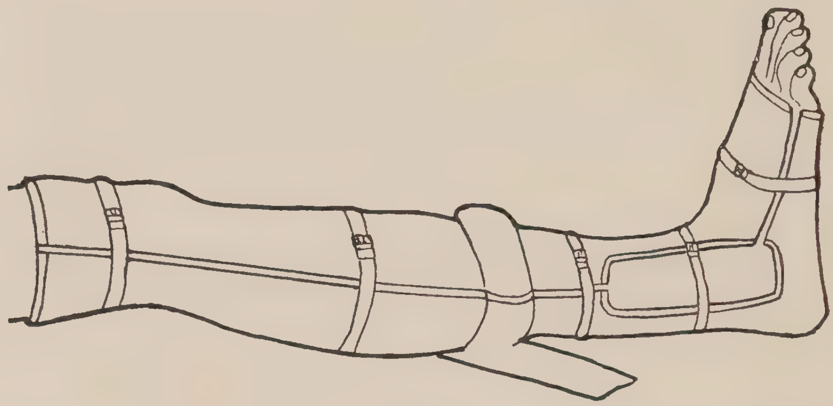

FIG. 447.—Method of splitting a plaster of Paris applied to the leg, allowing the front half or the posterior half to be removed. There is a window cut when necessary to allow inspection of the dressing. There is a plaster rope flattened so that the leg will not rotate. The plaster is held together with webbing straps. A knee plaster should reach high on the thigh. (See figure 448.)

part is applied and then brought into position and strapped to the elbow splint. In difficult cases this method of application has been found very satisfactory.

334. Plaster of Paris Bandage after Operation on the Knee.—In the application of a plaster to the knee after operation for correction of deformity, the sheet wadding should fit perfectly. The plaster should reach high in the groin in order to get a grip on the upper end of the femur, the plaster should hold the lower end of the femur snugly, also the upper and lower end of the tibia and the foot and ankle. If the plaster does not resemble the shape of the leg after its application there is apt to be more or less motion at the knee which may interfere with the result of the operation. The knee should always be bent a little backward, and a little hyperextended during the application of the plaster. This is necessary only in correcting the deformities at the knee. In straightening the knee, pressure should be made above and not over the knee cap. Pressure on the patella maintained by the plaster may cause it to be adherent. The foot and ankle are included in the plaster whenever the knee is sensitive or the operation has been extensive. A plaster rope is applied around the finished plaster (see

FIG. 448.—End view of plaster (figure 447). Notice that the heel is held off of the table. A plaster rope flattened prevents rotation of the leg and makes sand bags to steady the leg in bed unnecessary.

figures 447 and 448) extending on either side of the plaster preventing the leg from rotating on the table or bed. This rope may be placed at the calf. When the knee is exquisitely tender, the plaster should include the joint above as well as the joint below. The plaster is split at the sides and held together with webbing or adhesive straps or a wet bandage (see figures 156 to 158). Windows are cut for inspection of the dressing without disturbing the joints. Extremely large windows may be provided for by re-enforcement with plaster rope (see figure 449).

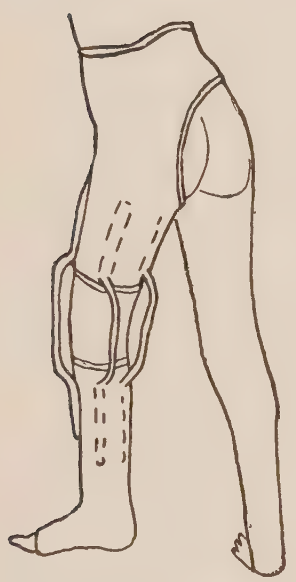

Fig. 449. — Method of applying a plaster exposing the knee for extensive dressings but immobilizing it completely. The re-enforced portions of the plaster across the knee are plaster ropes incorporated in the leg and in the thigh plaster.

Fig. 450. — Method of immobilizing the hip and allowing it exposed completely when extensive dressings are necessary. The plaster ropes are placed some distance from the skin and join the pelvis with the leg portion of the plaster.

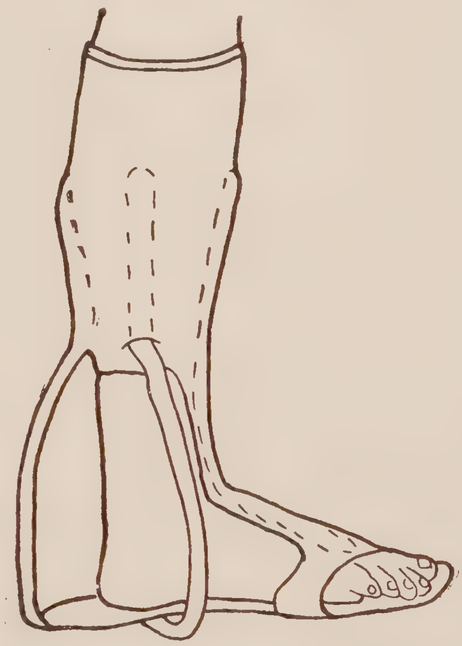

Fig. 451.—A method of applying plaster and maintaining position of the foot but allowing the heel and ankle to be exposed for dressing. (See figure 452.)

335. The Application of a Plaster of Paris Bandage after Operation or Manipulation of the Knee.—To facilitate the correction of knock knee or bow leg and at the same time to obtain a slight hyperextension of the knee during the application of plaster, the following method is of service in very muscular individuals or when much force is necessary. The leg having been covered with sheet wadding from the toes to the groin, a heavy felt pad is placed just above the knee, a double four inch bandage is spread over this pad and its four ends carried down to a leg or cross bar on the operating table and tied there (see figure 76). The operator can then slightly hyperextend the knee and correct bowing or the knock knee during the application of the plaster.

When the plaster has hardened the bandage is cut away from its attachment. In cases where correction of the knee deformity has been done the plaster should extend high on the thigh. It should grasp both

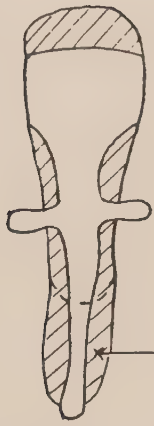

FIG. 452.—Plantar view of figure 451. The lined portion is a padded wooden splint. The white is a plaster and extends beyond the heel. Dotted line marks the heel.

FIG. 453. — Front view of plaster (figures 451, 452). The plaster may reach to the knee or above the knee. For a very complete fixation it should reach above, the knee being flexed slightly to prevent rotation of the plaster.

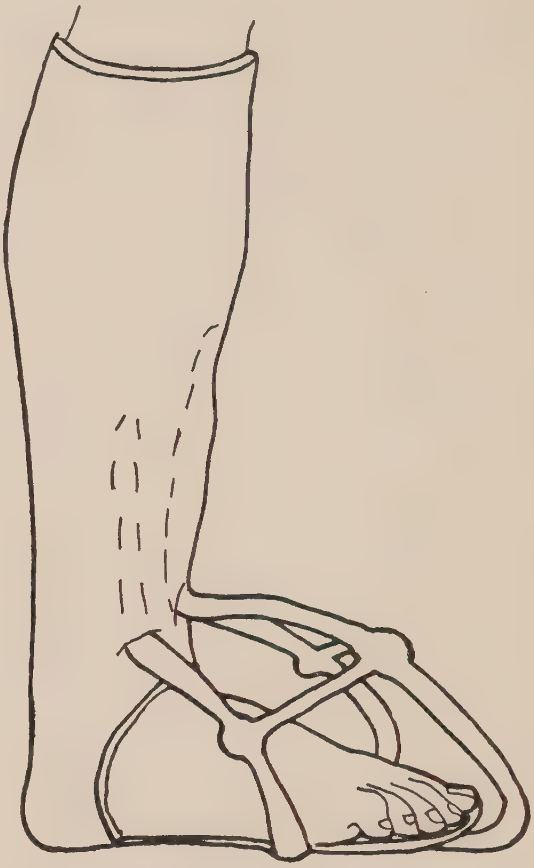

FIG. 454.—Plaster of Paris applied with a padded wooden sole splint and "plaster ropes" acting as a cage and holding the foot at right angles. This is useful for extensive dressings.

ends of each bone and fit the thigh well and fit the leg and foot well. Only in this way can the full correction be maintained.

A Simple Method of Preventing Rotation of a Leg Plaster. — Plaster ropes are applied to prevent the rotation of the leg as shown in figures 447 and 448.

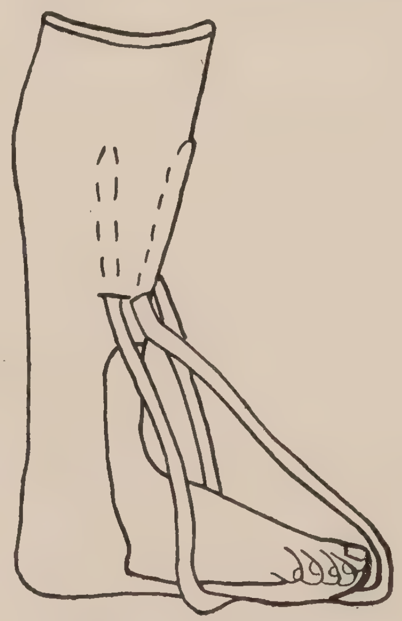

FIG. 455.—An arrangement for exposing the front of the foot for dressings and maintaining position of the ankle by means of plaster of Paris.

FIG. 456.—Plantar view for either figure 454 or 455. Dotted lines show the "plaster ropes" as they extend into the plaster.

336. Plaster of Paris Bandage after Operation on the Foot. — In the application of a plaster for holding the foot, it is important to hold the ball of the foot firmly without cramping the toes. A small strip of cotton may be placed

between the toes and folded back over the foot. It is removed after the plaster is hard. This will give room for the toes. In using pressure on the ball of the foot, for correction during the application of a plaster, the surgeon should not extend the toes at the head of the metatarsal. The heel should be padded well; pressing the plaster into the heel should be avoided. Pressure over the dorsum of the foot near the tibia should be avoided, either directly with the hand or forcing in the plaster during the correction of deformity. When correction is made the plaster is apt to wrinkle here and cause a slough unless the surgeon is careful to get his correction and then apply the plaster. If the plaster is applied first and the correction obtained afterward the wrinkling of the plaster is apt to result. Methods of holding deformities during the application of a plaster have been given for this purpose after each operation. In applying a plaster to the foot after correction of a deformity, when the knee is normal the plaster is applied with the knee slightly bent to prevent the rotation of the plaster on the leg. When the condition or an operation on the knee will not allow this position, a plaster rope included in the plaster can be used to prevent rotation. It extends out at either side preventing rotation of the leg in bed (see figure 447). It may be necessary to apply the plaster around the pelvis to prevent the plaster from twisting if the knee must be kept straight. This should be avoided when possible as it complicates the care of the patient in bed. See figures 451 to 456.

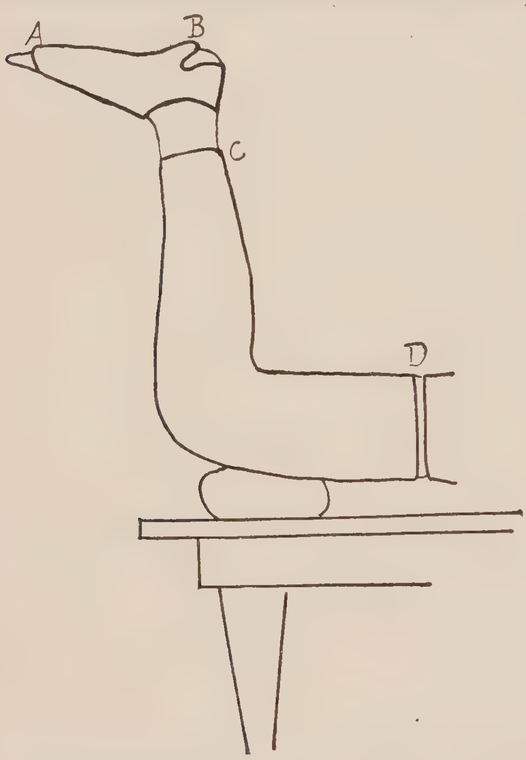

Fig. 457.—Dr. Bradford's position for manipulation of the foot. This position is used during the application of the plaster bandage following operation on the foot. The plaster is put on the foot from A to B; only two turns around the heel to hold this "foot-cuff" on. The knee is flexed and a plaster put on from D to C. When these portions of the plaster have hardened the foot is held in position and the plaster is finished uniting the foot and leg portions.

Fig. 458.—Position of the foot following club foot operation. The foot is abducted, dorsally flexed and the cuboid raised.

Fig. 459. — Shoulder plaster with plaster ropes used when extensive dressings are necessary.

337. Application of Plaster for Varus or Equino Varus, Club Foot Plaster.—Some care is necessary in applying a plaster to the foot for correction of bone deformity. A liberal quantity of well fitting sheet wadding is applied to the foot and leg, an extra amount being placed over the heel and between the toes. About eight layers of plaster bandage are applied around the ball of the foot and metatarsals, two layers only around the heel to prevent this cuff from slipping off. This is allowed to harden while the plaster is applied to the thigh and leg with the knee flexed eighty degrees. When these two portions are hard, the patient is turned over on his abdomen and a pillow is placed under the knee. The operator holds the foot overcorrected (see figures 457 and 458) while an assistant joins the two portions of the plaster. In this way there is no cramping of the toes which are held flat and the plaster is applied to the deformity which is held corrected. If the operation has been thoroughly done the foot will easily overcorrect without force. Good overcorrection of the deformity is a sure method of preventing pressure sores and discomfort from the plaster. The position of overcorrection of the foot in plaster is important. A vertical line through the middle of the lower leg is drawn on the plaster. This line should be determined by an imaginary plane passed through the femur and tibia. The foot should be abducted fifty degrees from this plane. It should be dorsally flexed about twenty-five degrees, the cuboid being raised more than the rest of the foot (see figures 457 and 458).

Fig. 460. — Shoulder plaster used when extensive dressings are necessary.

Fig. 461.—Method of splitting a plaster with two or more jogs so that the two halves are accurately placed together. This jogging of the plaster may be done for jackets as well as for other plasters.

Fig. 462. Plaster knife. These plaster knives are made to cut leather; they may be obtained by the dozen at less than ten cents apiece. It is easy to cut with the point without endangering the patient.

338. Plaster of Paris Bandage for Valgus.—A plaster of Paris bandage is applied from the toes to the groin with the knee bent, as follows: a liberal quantity of well fitting sheet wadding is applied to the foot and leg, an extra amount being placed on the heel and between the toes. Eight turns of the plaster bandage are placed over the ball of the foot and around the metatarsals in front. Only one or two turns are made around the heel to hold the cuff on. The cuff is allowed to harden while the plaster is put on from above the ankle to the groin with the knee bent. When this has hardened the patient is turned over on his abdomen, the knee rests on a cushion, the operator holds the ball of the foot in a dorsal position and adducts it, correcting the deformity while the plaster is completed between the foot cuff and the leg. The heel should not be allowed to be dented or to rest on the table or bed. After an extensive operation, the patient is kept quiet for three weeks. After that he is allowed to sit in a chair. At the end of the fourth week he walks on the other foot using crutches. Weight-bearing is allowed in the eighth week depending on the case; always with the plaster at first. After the eighth week the knee may be flexed twenty degrees only.

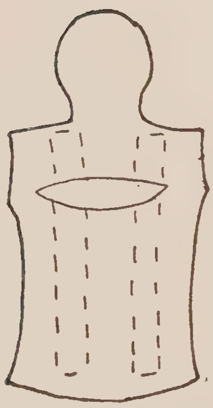

Fig. 463.—Posterior view of plaster shell showing the method of cutting out a lozenge-shaped piece of plaster to allow the shell to be hyperextended at any point selected by the surgeon. Sometimes it is better to cut out triangular pieces as shown in figure 464. After bending the plaster it is re-enforced by heavy plaster ropes as shown in the dotted lines.

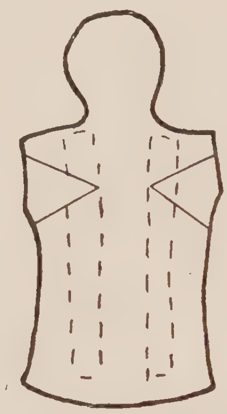

Fig. 464. — When the plaster of Paris shell is made on the patient it must be hyperextended often at the point selected by the surgeon. Triangular pieces are cut out at either side of the plaster or a lozenge piece is cut out of the middle as shown in figure 463. This allows the bending of the plaster. It is then re-enforced as shown by the dotted lines and the shell completed as shown in figure 465.

Fig. 465.—Posterior plaster shell for maintaining position of the spine in recumbency. This shell will not rotate.

Fig. 466.—Cross section of plaster shell, showing the plaster portion resting on the table preventing rotation.

In infantile paralysis, as in congenital valgus, overcorrection is made with the feet in marked adduction so that they interfere in walking. This is maintained for at least six months. Walking is made possible by wooden or plaster wedges under the sole of the plaster.

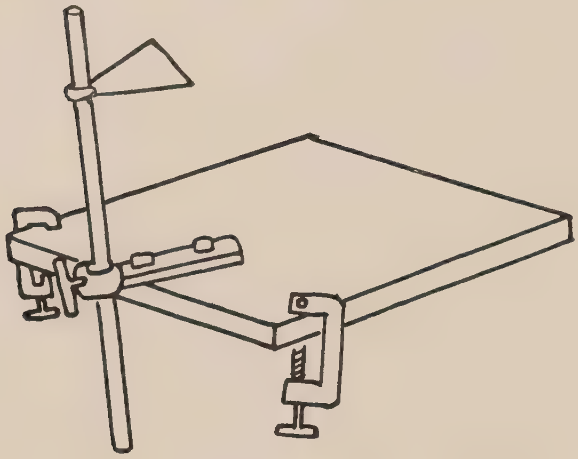

Fig. 467.—This board with a pelvic rest is fastened to any table and is used to support the sacrum during the application of a pelvic plaster.

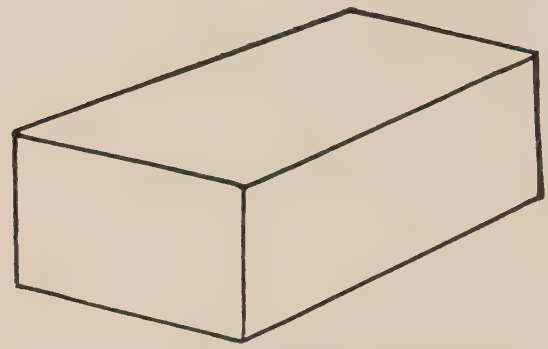

Fig. 468.—A box used to support the thorax of a patient during the application of a pelvic plaster.

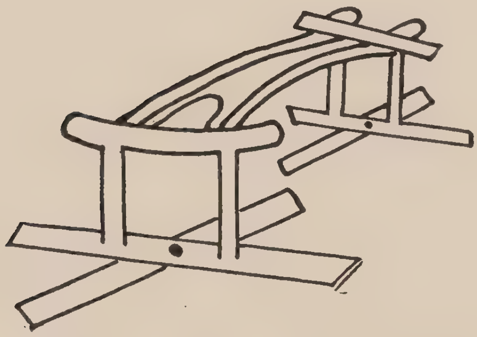

Fig. 469. — Portable Goldwait frame for the application of plaster jackets.

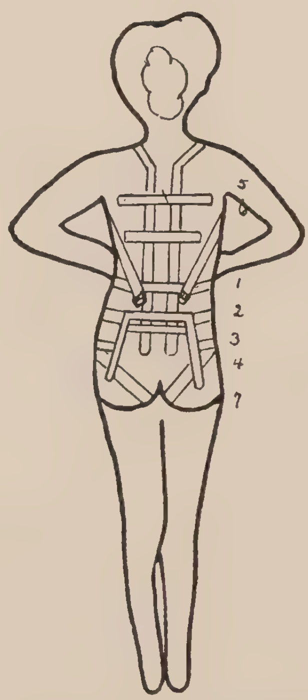

Fig. 470. — Posterior view of modified Taylor back brace. The U piece should be broad and extends down almost to the tuberosity of the ischium at the side. Its top should be broader than the posterior superior spines; the uprights rest on the transverse processes, the cross bars help to immobilize.

Fig. 471. — Shows the front view of the two leather or canvas aprons used to hold the Taylor brace in place.

339. Plaster of Paris after Operation on the Toes.—There is some difficulty in maintaining the overcorrection of hammer toe in a comfortable manner without interfering with the circulation.

In the first place, as in the case of any deformity, the overcorrection after operation should be so complete that the toe may be put in any position without force or tension. A well fitting plaster is then applied to the ankle and ball of the foot, often the leg is included.

Incorporated in the dorsal part of the plaster are five digit-like pro-

Fig. 472. — Side view of the straps and the Taylor back brace.

Fig. 473. — Bradford abduction splint and high sole. Back view.

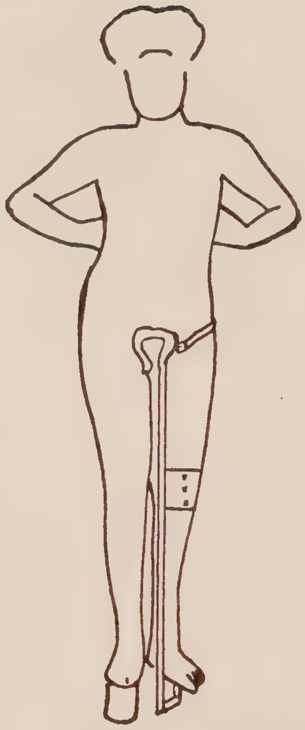

Fig. 474.—Bradford abduction splint and high sole, front view. This splint is practically a Thomas knee splint with one-half of a Thomas ring on the opposite side, the two connected by a pubic iron in the shape of a horse shoe. This pubic portion is from two to three inches broad. The measurement of the Thomas knee splint is otherwise the same.

jections made of plaster bandages moulded to protrude beyond the toes (see figures 190 to 194). When they have hardened a pad is placed under each projection, holding its metatarso-phalangeal joint flexed; a felt pad is then placed under the ball of each toe and a gauze bandage is looped around the toe and felt pad drawing it up to its plaster digit, holding the phalangeal joint hyperextended (see figure 190).

A similar plaster may be used for the hand when a wire or aluminum is not available. The splint is preferable for the fingers.

This method of applying plaster is perfectly comfortable if the operation is done completely so that no force is necessary to hold the over-correction.

CHAPTER III

PREPARATION FOR OPERATION

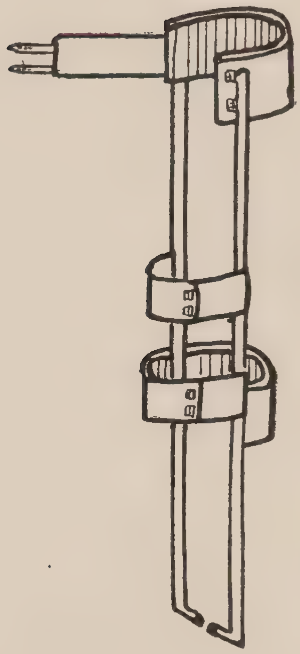

FIG. 475.—Long caliper splint used to immobilize the knee and ankle with two leather anterior bands, one to hold the upper end of the tibia, the other the lower end of the femur. One or both of these may be used, depending on the use of the brace. If an operation has been done above the patella, it is better to use the lower band only. If an operation has been done below the patella it is better to use the upper one only. Where the splint is used and no operation has been done in front of the knee, an ordinary knee band, as shown in figure 476 may be used instead of these two anterior bands. This splint fits into a socket attached to a shoe. It reaches from one and one-half inches below the fold of the buttock to the sole of the foot. The uprights follow the outline of the leg. A tracing is taken of the leg for this purpose. This splint may be made with a joint at the knee which locks or allows varying degrees of motion. (See figure 478).

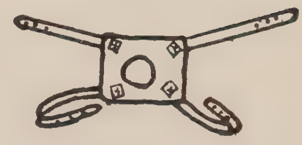

FIG. 476.—This is a knee cap which fits over the patella and is used to keep the knee straight when used with a long caliper splint. (See figure 495.)

FIG. 477.—Short caliper splint used to immobilize the ankle. This splint fits into a socket attached to a shoe. This splint reaches from the tuberosity of the tibia to the sole of the foot. (See figure 478).

FIG. 478.—The caliper splint (see figures 475 and 477) may be arranged at its lower end with a caliper stirrup as shown above. This allows the splint to be fastened to the shoe by means of straps instead of having a socket made in the shoe for the purpose of holding the splint. One strap goes over the midtarsus, the other over the heel of the shoe.

340. Preparation for Operation.—In the preparation of the patient for operation the skin must be clean and free from irritation. If iodine is to be used, the surface should not be bandaged tightly beforehand. Soap and water should not be used for at least twenty-four hours before iodine. For shaving previous to the use of iodine, a paste of water and talcum powder or plain water is used, the application of $3\frac{1}{2}\%$ tincture of

iodine will be sufficient for the preparation of a fairly clean skin. Where it is necessary to use soap and water it is not advisable on the chronic debilitated patient to follow this with tincture of iodine. When

FIG. 479. — Method of re-enforcing the boot to immobilize the ankle. A piece of sole leather (dotted portion) is stitched inside of the shoe, on both sides of the ankle. A hole is cut in the sole leather where the malleolus rests.

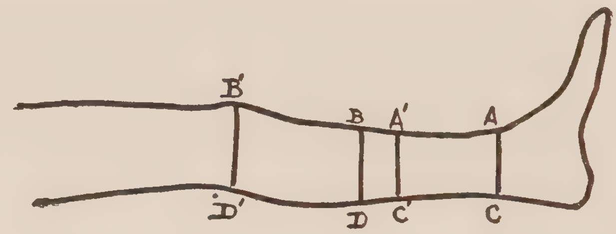

FIG. 481.

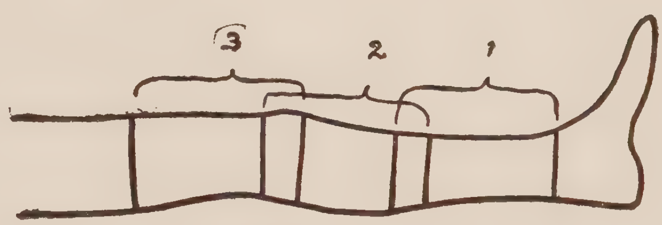

FIG. 482.

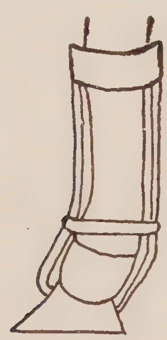

FIG. 480. — Posterior view of a short caliper splint applied to hold the ankle in an over corrected position. Notice the wedge under the shoe and the extension of the wedge laterally. The caliper is bent to maintain the over corrected position desired.

FIG. 483.—Method of holding the leg when the skin of the foot and ankle are being prepared for operation.

it is necessary to use soap and water the part is thoroughly scrubbed with water and green soap on a gauze sponge. The skin is first shaved, cleaned with soap and water, the soap is then entirely washed off with fresh water and the skin thoroughly scrubbed with a 70% solution of alcohol or with Harrington's * or some other solution on a gauze sponge.

*(Harrington solution)

Bichloride of Mercury	1 5-10 grams
Hydrochloric Acid	100 cc
Glycerine	100 cc
Alcohol	1200 cc
Distilled water	2000 cc

The alcohol should be used very freely from a basin sterilized by boiling and the scrubbing systematically done.

When there is to be much manipulation at the time of operation, the iodine preparation should not be used, any friction over iodine will cause blistering of the skin.

In "cleaning up" a patient and in placing the protective towels and sheets, etc., the assistants should be trained to be systematic and rapid; one space should be taken up after another and done thoroughly. There should be no waste of time or delays, a nurse should be ready with each covering for the patient, handing it promptly to the assistant in the order it is expected.

Fig. 484.—The skin is sterilized from M to N.

In "cleaning up" a leg or an arm the following method may be used:

Fig. 485.—A sterile towel is put on the sterilized skin above.

341. Preparation of the Leg and Foot for Operation.—The hair is shaved the day before, using no soap if an iodine preparation is to be used. When iodine is not used the upper end of the leg is cleaned by the nurse, starting at the front of the upper end of the thigh (see figure 481), a section of the leg is scrubbed from (a-b) to (c-d) on the outer side and then back from (c-d) to (a-b). Another section is next cleaned on the inner side from (a-b) to (c-d) and then back from (c-d) to (a-b). This process is repeated twice. The nurse next cleans in a similar way the next section of the leg which overlaps the first section and extends from a-prime, b-prime, c-prime, d-prime. In the same way the third section is made to overlap the second and a fourth section overlaps the third and so on down the leg (see figure 482). In this way the leg is cleaned completely first with soap and water and second with the antiseptic solution desired. Additional cleansing may be used at the regions where the incisions are to be made. When the foot is to be prepared a nurse holds the leg just below the knee as seen in figure 483.

When the foot is thoroughly cleaned it is held by a sterile nurse with a sterile towel. The leg is then cleaned up from below upward, using one section after another as demonstrated in figure 482. When the leg is thoroughly cleansed it is still held by a clean assistant while a sterile sheet is applied over the operating table, under the leg, second, a sterile towel is wound around the cleaned skin, high up on the leg to mark the sterile limit (figure 485). This towel overlaps the sterilized skin and is clamped or tied so that it will not expose the nonsterile skin. A sheet is placed over the patient and the upper leg, covering

it below the towel which has just been mentioned and clamped around it. The patient is then ready for operation. One or more sand bags are useful in an operation on the leg, arm and foot. A sterile sheet doubled is placed on a sterilized table, a sand bag placed on it, the sheet is folded over it several times and the edges turned in. The sand bag may then be handled by the operator and his assistants.

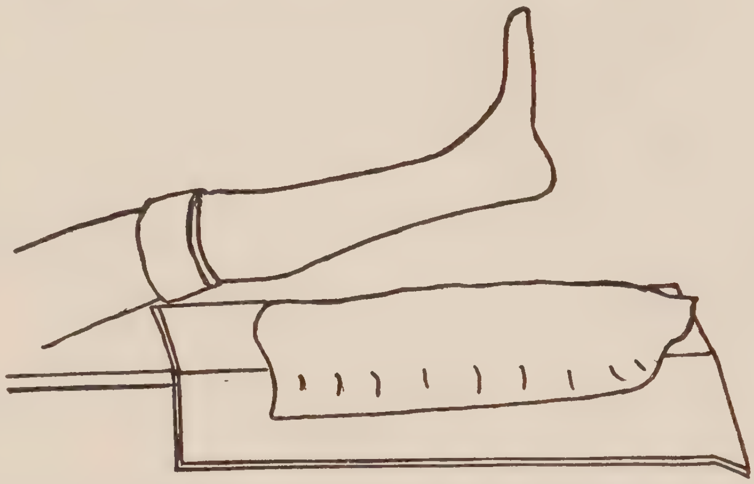

Fig. 486.—A sterile sheet is put on the operating table, another over it. The foot is placed on the second sheet. (See figure 487.)

When a middle portion of the leg is to be operated upon, as for instance the knee, the leg may be prepared in the manner described above from the points (m-n) (figure 484) a non-sterile assistant holding the foot so that the leg is off of the side of the operating table and easily cleaned on all sides.

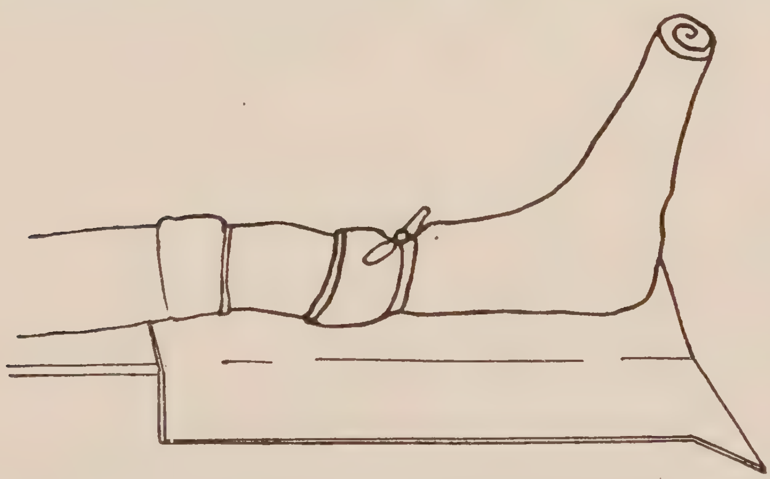

Fig. 487.—The sterile sheet covers the lower part of the sterilized skin (figure 484) and the foot around which it is folded and tied. (See figure 488.)

When the leg is surgically clean, a doubled sterile sheet is placed on the operating table while the leg is held up, second, the sterile towel is rolled just below the point cleaned up above the knee (m) and another just above the point cleaned up below the knee (n); third (see figure 490) a doubled sheet is laid over the patient, and the leg and upper leg towel. A sheet is placed on the operating table (see figure 486). The nurse lays the foot and presses it in place on this sterile sheet and wraps it around the leg as in figures 487, 490. The loose end beyond the toes is folded back over the foot. This is tied with a strip over the foot, around the ankle and around the leg. Instead of using strips, a towel folded five or six inches broad and rolled may be bandaged around the foot and ankle to hold the sheet in place. This will give firmness and keep the sheet from slipping during manipulation of the leg (see figures 491 and 492). The advantage of using a sheet to envelop the lower leg and foot is, first, the saving of time as it is not necessary to prepare this great

extent of skin and second, the operator is able to manipulate the leg which is protected in a sterile sheet.

342. Preparation of the Knee Flexed at Right Angles for Operation on the Semilunar Cartilage, etc.—The knee is prepared and protected as described above. Sterile sheets include the leg above and below the knee and the foot. The end of the operating table is let down and the patient's leg allowed to flex at right angles off of the end of the table. Sterile sheets protect the leg from the tableleaf and hang from the operating table almost to the floor. The surgeon may stand or may sit in front of the knee and rests the foot on a sterile sheet placed in his lap over his gown. Assistants stand on either side of the knee.

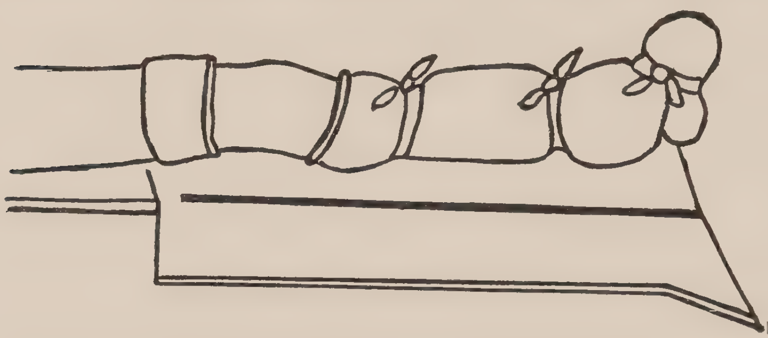

Fig. 488.—The foot and leg are now well covered with sterile sheets which cannot slip in manipulation of the leg. (See figure 489.)

343. Preparation of the Arm for Operation.—When the elbow or arm near it is to be operated on, the preparation is similar to that described for the middle of the leg. For the forearm or hand the preparation is used as described for the leg and foot.

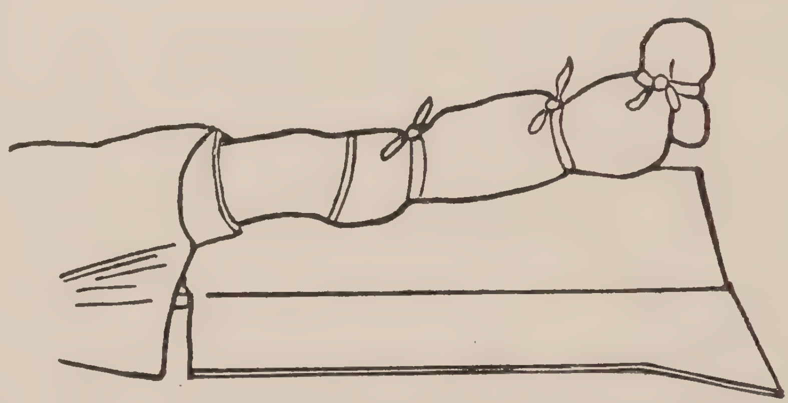

Fig. 489.—A double sheet is now placed over the upper sterile towel and clamped. (See figure 490.)

344. Preparation of the Shoulder for Operation (see figure 493).—In operation on the shoulder the preparation should be made from the middle line on the thorax anterior to the middle line posterior, and as far down as the waist. The arm is prepared to the elbow. In the preparation of the shoulder and outer scapula region the patient lies on his back with hard pillows or sand bags or sawdust bags holding the pelvis rotated forward forty-five degrees. A large sand bag beneath the shoulder blades holds the posterior deltoid region six inches off of the operating table.

As soon as the patient is anæsthetized he is placed on these cushions. If the right side is to be operated upon he is then rolled well over on the left side to give access to the back. The scapula and trapezius region are cleaned with sterilizing solution to the median line, also the shoulder and arm to below the elbow. The front of the chest is sterilized to the median line and to below the nipple, lower if necessary. A double sterile

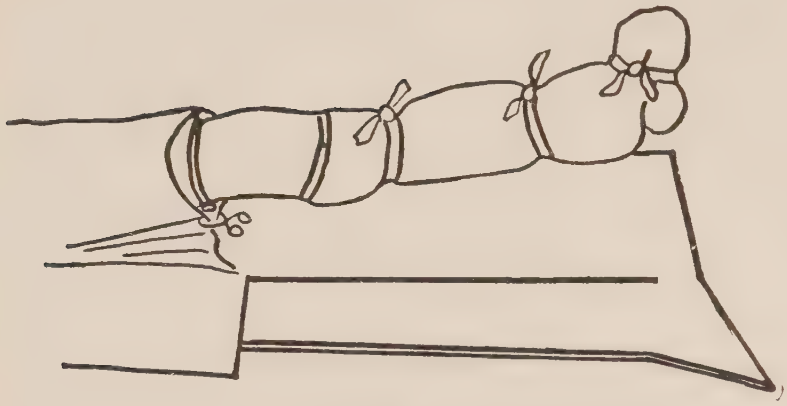

FIG. 490.

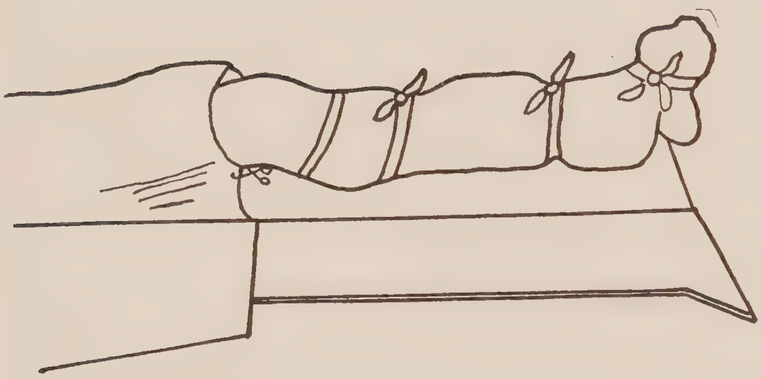

FIG. 491.—The knee is now ready for operation. (See figure 492).

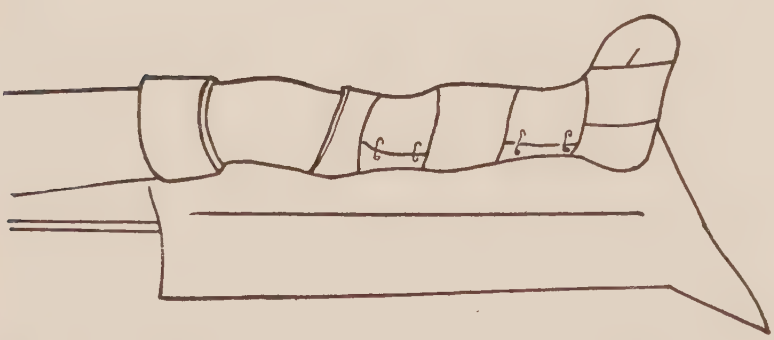

FIG. 492.—The sheet on the foot and lower leg may be fastened with towels as shown in figure.

FIG. 493.—In operations on the shoulder a sand or sawdust pillow is placed to the inner side of the scapula. The shoulder is near the side of the operating table. This position makes the shoulder accessible in front and behind without changing the position of the patient during the operation.

FIG. 494. — The osteotome on the market; side view of its blade, as it should not be; there should be no sudden shoulder near its cutting edge. The surgeon should be able to feel with the end of the osteotome; any sudden curve or shoulder is a disadvantage. (See figure 496.)

FIG. 495.—The flat side. An osteotome should have a large handle so that it may easily be controlled. Its sides should not flare too much.

sheet is placed under the scapula and thorax over the sand bags, the patient is then allowed to roll back into the position at first described. The hand which is not sterilized is still being held by a non-sterile nurse. A sterile sheet doubled covers the head and neck. It is caught above the shoulder by clamps to the sheet on the table. Another sheet doubled reaches from the neck across the chest above the nipple continuing off of the operating table. This sheet is clamped to the second sheet at the neck and to the first sheet at the side of the operating table. A fourth sheet doubled is placed over the rest of the abdomen and legs, covering the patient and the operating table completely. The non-sterile hand and forearm is still held by an assistant. A doubled sterile sheet is placed over the thorax just below the shoulder. The non-sterile assistant places the hand, forearm and elbow firmly on this sheet and steadies it by the non-sterile part until a clean assistant grasps the sterile arm above the elbow and steadies it while the sheet is folded from without inward over the arm and hand. The inner part of the sheet is then folded over. The end of the folded sheet beyond the fingers is turned back over the hand. Two towels folded five or six inches broad and rolled are now used. One is bandaged about the wrist holding the turned over end of the sheet, the other is bandaged about the elbow holding the sterile sheet well above the elbow. These towels are pinned or clamped. Gauze strips may be used instead of the towels. The folded flat towel holds the sheet firmly and has body enough to prevent slipping.

345. Preparation of the Elbow for Operation.—In the preparation of the elbow for operation, the patient lies on his back, a non-sterile nurse holds the hand of the arm to be operated upon.

The arm is cleaned from the wrist to the axilla in a manner described for cleaning the leg. A sterile towel already folded, four to six inches broad and rolled is applied around the upper arm.

If it is necessary to operate high on the upper arm, the shoulder and axilla are prepared and a small sheet or double towel is looped around the shoulder as shown in figure 493. A sterile assistant now holds the arm just below the elbow. The operating table is now covered with sterile sheets, a large towel doubled is placed on the operating table. The assistant places the hand and lower third of the forearm on it. The towel should be large enough to fold around the hand at least three times. When folded the end extending beyond the fingers is doubled over the hand. One of two methods may be used, either a strip is placed around the hand and tied and another around the wrist and tied, holding the towel in place, or a towel previously folded four to six inches broad and rolled is bandaged to hold on the towel, covering the wrist and hand. The towel is clamped or pinned in place. The arm is now placed across the thorax or on the operating table or on a small table or on a shelf covered with a doubled sterile sheet.

346. Preparation of the Hand and Forearm for Operation.—If the hand is to be operated on, a non-sterile nurse holds the arm

firmly with both her hands just below the elbow, the patient's fingers and hand and arm are cleaned up to the forearm without disturbing the holder of the arm. A sterile towel previously folded, four to six inches broad and rolled, is bandaged firmly above the wrist and clamped. The hand is placed on a sterile table, a sheet doubled covers the arm from the wrist over the sterile towel.

FIG. 496.—Side view of an osteotome showing the gradual slant without any bulge near the cutting edge.

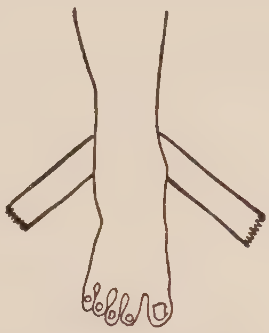

FIG. 497.—Dr. Hayward Cushing's knot for temporary traction during an operation. The tendo achilles and foot are padded with heavy pads such as saddle felt; then a heavy webbing strap is applied first to the back of the leg.

FIG. 498.—The strap is crossed over the tarsus which is well padded.

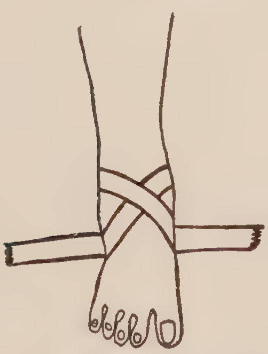

FIG. 499.—The straps are next crossed under the foot.

FIG. 500.—After crossing under the foot they are brought up on the sides of the foot and looped through the first part of the webbing.

FIG. 501.—When the straps are pulled tight a side view shows the pull near the malleoli preventing constriction of the ankle during the application of force.

For operations on the forearm, the preparation is similar.

347. Preparation of the Hip for Operation.—In the preparation for the right hip, the patient is placed on his left side close to the left edge of the operating table; the foot is held by a non-sterile assistant, the leg is prepared on all sides from below the knee to the perineum as described above. The assistant holds the foot high enough to afford easy access to all parts of the leg. The body is prepared from

the waist down to the leg, extending beyond the median line in front and behind. Four sterile sheets are now used on the patient, a fifth on the leg. When the patient is clean a doubled sterile sheet is placed on the operating table behind the patient; the patient is turned back over it. The leg is still held up off of the operating table by the non-sterile assistant. A sheet is placed under it over the non-sterile leg and operating table. A sterile sheet doubled is placed under the clean leg, close to the perineum and up over the abdomen, another covers the patient and table above the anterior spines. These are all clamped where they cross each other. The whole table and other leg are now covered with the fourth sterile sheet. A fifth doubled sheet is placed on the operating table to receive the foot of the cleaned leg which is placed firmly on it by the non-sterile assistant and held until it is steadied by the clean assistant, grasping the thigh while the outer edge of the sterile sheet is folded inward over the leg and foot. The inner part of the sheet is then folded around the leg. At the foot, the sheet beyond the toes is folded back over the foot; a towel previously folded four to six inches broad and rolled is bandaged and clamped around the foot and ankle to hold the sheet in place. Another towel like this is applied above the knee to hold the upper end of the sheet in place. This prevents any possibility of disturbing the protection during manipulation of the leg.

Fig. 502. — Plantar view showing crossing of straps.

Fig. 503.—The straps are tied together under the foot making a hook to which traction may be applied. When much traction is necessary the usual ordinary webbing may be used if three thicknesses are used folded together and used together.

Fig. 504.—Method of padding before applying the straps for traction (see figure 503). Heavy saddle felt (¾ of an inch thick) is used cut four inches broad and thirty inches long. It is folded over the tendo achilles and front of the foot; the padding may advantageously include the sole of the foot.

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The author will be glad to know of any methods or practical points that have been of value to surgeons in operations on bones, joints, muscles and tendons.
Any suggestions will be welcomed.

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